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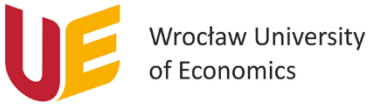

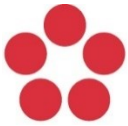

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Preface

Ladies and gentlemen, dear colleagues,
the Hradec Economic Days (HED) conference has been traditionally and continuously held since 2003. This year we are opening a new decade with our 21st HED which took place April 13–14 in Hradec Králové. The University of Hradec Králové organized the conference in cooperation with the University of Pardubice Faculty of Chemical Technology, the Wrocław University of Economics, the Cracow University of Economics the Office of Transfer of Technologies at the University of South Bohemia, and Charles University Innovations Prague, Plc.

The aim of the HED 2023 conference was to present the results of scientific research activities in the fields of economics, business economics, and management. We became a regular platform for meeting experts from such disciplines strengthening interdisciplinary relations and establishing personal contacts important for the submission of joint research projects and creating space for the presentation and publication of young members of an academic community. To fulfill these goals, we provided presentation sessions and a plenary session with foremostly keynote speakers:

- Jakub Seidler (Chief economist at the Czech Banking Association),
- Tale Skjølsvik (Vicedean at the Oslo Metropolitan University),
- Michal Pohludka (CEO & Co-Founder of the GeneSpector and the Macromo, Ltd.).

To boost academia and practice interconnection we prepared also special sessions:

- Technology transfer discussion session with successful practicians and entrepreneurs from the Czech Republic and Malaysia.
- Project management panel discussion with IPMA® Czech Republic.
- Special guest speech by Jaromír Zahrádka on Investing in Technology Transfer.

Proceedings from the conference HED 2023 contain 92 contributions in English. The authors of the conference papers were academics and other professionals from the Czech Republic, Poland, China, Slovakia, Norway, Albania, Bulgaria, Serbia, Ireland, Ukraine, Sweden, and Pakistan. I would like to warmly thank all participants of the HED conference for their contributions and favor. My special thanks go to Mrs. Václava Hamplová who participated in typographic and other proceedings-related supportive tasks for more than ten years. The final recognition belongs to the HED secretary assoc. prof. Ivan Soukal, editor Dr. Jan Mačí, our organization, and scientific committee for their work. I would like to thank our co-funding our partners: the project EHP-CZ-ICP-3-010 of EEA Funds 2014-2021 Education Program, the project 2020-1-CZ01-KA203-078313 "Technology transfer together" of e Erasmus+ Programme of the European Union, and the grant no. 22RGI02-0380 of the the Hradec Králové region.

Hradec Kralove, April 11, 2023

Assoc. Prof. Petra Marešová
General Chairman of Hradec Economic Days
Faculty of Informatics and Management
University of Hradec Kralove

CONTENT

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Demands of the Selected Clientele in the Spa Hotel Industry after the COVID-19 Pandemic – Pilot Research

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Abstract: This paper presents the results of a pilot research conducted on a sample of potential clientele in the spa hotel industry in the context of the impact of the COVID-19 pandemic. It is important to pay attention to which factors are important to the potential clientele in the spa hotel industry to attract more visitors to a spa destination. In particular, domestic clientele are important in the recovery of the spa industry after the pandemic. The pilot project focusses on the spa industry of the Karlovy Vary region and potential clients from the Capital City region. Based on a questionnaire survey and hypothesis testing, conclusions are formulated concerning mainly the use of travel agencies and the offer of experiences that tourists could potentially attract when deciding on their accommodation after the COVID-19 pandemic.

Keywords: hospitality industry; pandemic; time series; tourism; wellness

JEL Classification: M21; M31

1. Introduction

As globalization advances, so does tourism growth, which is turning into one of the largest and fastest growing economies in the world (UNWTO, 2013). Global travel and tourism contribute significantly to job creation and, of course, socioeconomic and cultural development worldwide (McCabe & Qiao, 2020).

The concept of spa and wellness plays an important role in its own right. Spa and wellness tourism, also known as the "health industry", started to develop in the world in the 1990s. Since then, interest in holidays associated with wellness or beauty treatments has been systematically growing (Kaleta, 2012). According to Mitríková et al. (2017), the spa industry is perceived as the provision of health care and activities that are aimed at treating the physical and psychological problems of a person. It is a type of tourism that requires certain natural resources and the supervision of professionals such as physicians. The term "wellness" is part of a healthy lifestyle that implies well-being, optimal health, and a good mental state. Through wellness, an individual maximizes their potential (Abram & Kosińska, 2016) and can lead to a successful life (Smith & Puczko, 2009). According to Chuka and Shenk (2012), spa and wellness tourism is one of the most important types of tourism.

Europe, as a world tourist destination, boasts the greatest diversity. Tourism is a key sector of the European economy (2010). Europe is also rich in spas, some of which have been designated as UNESCO World Heritage Sites and may have positive visitor potential. In the Czech Republic, this is the case of Karlovy Vary (UNESCO, 2021).

The general satisfaction of a visitor to tourism, including spa tourism, is shaped by several aspects that contribute to the quality of a destination. It is the primary potential of the destination, which can be understood as natural and cultural attractions, as well as the services provided by the place, accessibility or sustainability aspects (Ryglova et al., 2015). Tourists increasingly wish to have their stay enriched by a spa experience, which they perceive as a complementary activity to standard leisure activities. Thus, determining the benefits and trends of spa tourism becomes important for developing effective management strategies for sustainable economic growth (Wong & Chang, 2009).

Visitors may perceive an added value in a spa stay in that they can choose to have a cultural experience or participate in various excursions around the spa destination in addition to the type of spa treatment, relaxation and wellness treatments, accommodation or meals (Vystoupil et al., 2017). Smith et al. (2016) highlighted the importance of service innovation in creating spa experiences. Tooman et al. (2013), Hindley and Smith (2017) highlight those expectations and preferences need to be considered when creating a spa experience.

In March 2020, the global pandemic COVID-19 arrived, causing economic crises around the world and the tourism industry was severely damaged. The tourism and hospitality industries were hit by travel bans, strict restrictions (called lockdowns) and safety regulations aimed at preventing the spread of COVID-19 (Jones, 2021). The reduction in foreign tourists due to border closures and the need to keep physical distance caused great losses to tourism and transport companies, some of which had significant financial difficulties or went bankrupt. The high vulnerability of the sector is due to the characteristics of tourism services, which are not classified as basic vital services, and is also affected by consumer mobility (Chang et al., 2020; Palacios-Florencio et al., 2021).

Spas in the Czech Republic were highly frequented by foreign visitors in the period before the COVID-19 pandemic. Historically, spas have always been a center of tourism, both domestic and foreign. The crisis associated with the COVID-19 pandemic has had a significant impact on the spa. Moreover, in the last decade there has been an underestimation of the spa industry and its importance to the economic and social environment. From reduced investment to staff shortages and poorer marketing management performance, to slow adaptation to current changes (Janeček & Jakubíková, 2021).

Spa or health tourism has been the focus of much of the literature and authors who have sought to find ways in which natural assets i.e., spa resources, facilities or people working in the area can influence the economic development of the area. For example, Michalkó et al. (2013) investigated the relationship between tourism and the quality of life of the inhabitants of a spa town, and it was found that the existence of a spa has significant benefits for the life of the inhabitants of a spa area. Janeček and Jakubíková (2021) examined attitudes of Czechs towards spas during the COVID-19 pandemic.

The research question to be addressed now is "which factors are important for potential clientele in the spa hotel industry after the COVID-19 pandemic, so that more visitors can be attracted to the spa destination, with a focus on domestic clientele". Indeed, it is the latter that has proved to be important in the recovery of the spa industry after the pandemic as the

world faces successive challenges. The main objective of this paper is to present the results of a pilot study that focused on the potential clientele of the spa industry in the Karlovy Vary region.

2. Methodology

Pilot research methodology includes a qualitative investigation, which was conducted through semi-structured interviews with representatives of the economic departments of selected spa hotels in the Karlovy Vary area. Five hotels were involved in the pilot research. The aim was to determine the current economic situation of the spa industry and, at the same time, to provide an overview of the state and the type of services offered. The semi-structured interview questions covered the area of the impact of the pandemic on spa hotel operators, characterization of hotel clientele, finances, loss of foreign clientele, the situation of surrounding hotels in Carlsbad, length of stay, travel agencies, security measures related to the COVID-19 pandemic, and services preferred by hotel clientele. This qualitative research was conducted between November and December 2021. Each interview lasted approximately 45 min.

Based on the information gathered, key factors were selected that were considered key by the spa hotel representatives or were identified as important by some authors (e.g., Janeček & Jakubíková, 2021). These factors became the basis for the questionnaire survey. The aim of the pilot questionnaire survey was to identify the preferred spa services by Prague clientele. Prague still has the strongest purchasing power and can compete with some foreign clients who used to visit some spa hotels. The respondents were selected by quota sampling and were contacted in Prague by electronic and personal interviews. The purchasing power index per capita of the capital city of Prague for 2018 is 128.7% (the highest in the Czech Republic) (Patočková, 2018). Respondents to the questionnaire were selected by quota sampling based on official data from the Czech Statistical Office on the population of the capital city of Prague region. For the purposes of this survey, persons in the age group 0-14 years are subtracted from the total population. Quota selection was set according to gender, age, and place of residence. The comprehensibility of the questionnaire was first tested on a sample of 10 persons.

The questions focused on the preference for particular hotel services, length of stay, selection of preferred food services, security measures within COVID-19, preference for travel agencies for domestic stay, visit to Internet (booking) portals, and also preference for an experience during the stay (e.g., museum visit). The questionnaire also included five sociodemographic questions. Data collection occurred between January and March 2022. The completion was carried out in an online environment and the average response time of the respondent was 12 minutes.

Subsequently, the data were processed in MS Excel software. Based on the literature, qualitative research with spa hotel representatives, and finally the results of the questionnaire itself, two basic assumptions emerged.

1. The cultural experience requirements related to a stay in a spa hotel differ according to gender.

2. The use of offering spa and wellness stays through a travel agency to make a spa stay in the country is related to the age of the potential clientele.

The testing of these assumptions, through hypotheses, is done through associations (Hindls et al., 2006).

Test criterion:

$$G = n\frac{(n_{11}n_{22}-n_{12}n_{21})^2}{n_{.1}n_{.2}n_{1.}n_{2.}} \quad (1)$$

$$The\ G\ statistic\ has\ a\ \chi 2\ distribution\ when\ H_0 is\ valid.$$

Degrees of freedom test for independence: $(k_1 - 1) * (k_2 - 1)$ (2)

3. Results

3.1. Results of Semi-Structured Interviews

The questions, in a semi-structured interview, covered the impact of the pandemic on spa hotel operators, characterization of hotel clientele, finances, loss of foreign clientele, the situation of nearby hotels in Karlovy Vary, length of stay, travel agencies, security measures related to the COVID-19 pandemic, and services preferred by hotel clientele.

Representatives of hotel operators agreed that the pandemic has affected hotels in terms of domestic and foreign clientele. The MICE segment, which includes meetings, team building, congresses, and conferences, as well as exhibitions and events, has also been affected. Some hotels have been renting some of their premises to third parties for a long time to run their business. These rentals are also a significant revenue stream that has declined considerably during the lockdown. In the catering sector, hotels still face a severe shortage of quality staff. The reason for the lack of staff is mainly due to the forced redundancy of staff during the pandemic, when waiters and waitresses in particular left to work in other sectors. To attract quality catering staff, it will be necessary to increase wages for some professions. The interview also included questions focused on the typical hotel client before the pandemic and the client in the post-pandemic period. Typical hotel guests in Karlovy Vary include Russian speaking clients who use spa services. In addition, there are also high net worth guests from Arab countries using spa services and the usual domestic guest using wellness services or conference services. Hotels are now expecting, but independently of the COVID-19 disease, also Czech clientele, and clients from the border areas, even to their families, for short hotel stays. Clients in hotels that use the most accommodation, spa, wellness, catering, and conference services. In terms of compensating for losses during the pandemic, some spa hotels used government support programmes, including spa state vouchers, to compensate at least in part.

During the interview, a more sensitive question was asked about whether domestic clients could compensate for pandemic losses. The hotels unequivocally responded that they could not. Domestic clientele is not in the habit of spending time and money on a 3-week medical stay in their home country, which is the core business of the companies. However, a more domestic clientele may also help mitigate losses and increase awareness of hotels.

Another question from the interview related to the previously described trend of people not taking advantage of long stays, but rather seeking rest or recuperation in a short period of time. Hotels follow this trend mainly with domestic clientele, who are more likely to seek long weekend stays, which are related to experience. According to the hotel, foreigners are more likely to stay longer. The pandemic has provided an opportunity for convalescent stays for home clients, but this trend does not appear to be significant in hotels. When asked about the use of travel agents or travel agencies to attract domestic clientele, hotels responded rather negatively.

3.2. Results of the Questionnaire Survey

Based on the primary qualitative research, the quantitative enquiry method was followed. 689 respondents participated in the questionnaire survey of which 50.28% were women and 49.72% were men. The age group 35-44 years has the highest representation in the survey, according to age. The second largest group is those aged 45 to 54 years. The third largest age group is the 25-34 age group. One of the questions in the survey focused on preferences for experiences during a stay in a hotel with spa and wellness care.

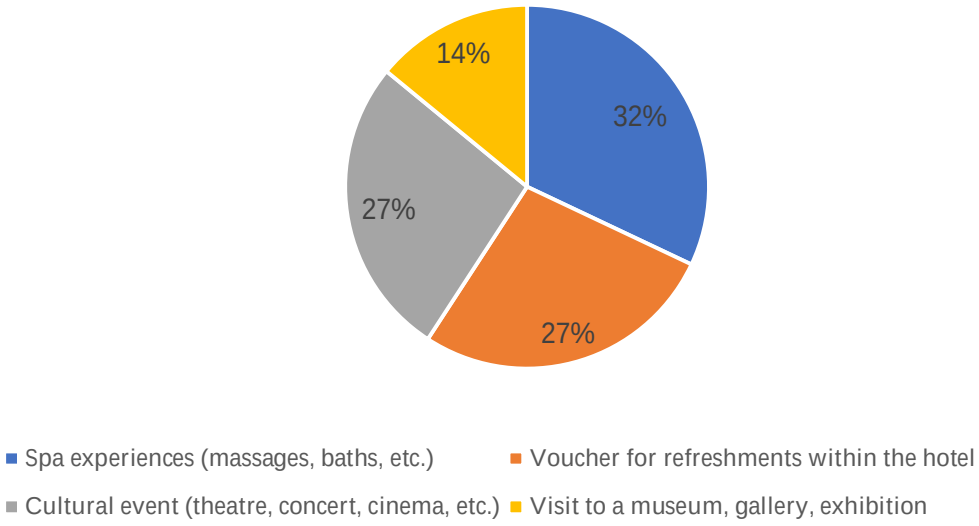

Figure 1. Preferences for experience when staying in a hotel with spa and wellness care

Figure 1 shows the distribution of interest in the experience. Shows that the greatest interest is in experiences related to spa care, such as massage or baths. Survey respondents could choose up to three experiences. Overall, therefore, 67.3% of all respondents prefer this experience. A voucher to the hotel café for refreshments would be used by 57.1% of the total number of respondents. There is also a high interest (56.3% of all respondents) in a cultural experience such as a theatre performance, concert, film show or other social event. On the other hand, there is a low interest in visiting museums, galleries, or exhibitions, with only 29.5% of the total number of respondents choosing this option.

The preference for experiences during the stay was the first relationship tested between sex and the request for cultural experience, with the test criterion $\chi 2 = 25.34234$. Quantile chi-square ($\alpha = 0.05$) = 3.841459.

Table 1. Hypothesis calculation

Test relation	Test criterion $\chi 2$	Quantile chi-square (α = 0.05)	Sig.
The relation between gender and the demand for cultural experience	25.34234	3.841459	Yes

The test, under the first assumption (relationship), rejected the null hypothesis H_0 at 0.05 level of significance and the alternative hypothesis H_1 is accepted, which states that there is probably a relationship between gender and the requirement of cultural experience to stay. Thus, the significance of the relationship was confirmed at the 0.05% significance level.

The questionnaire survey also investigated specific preferences based on gender (see Figure 2).

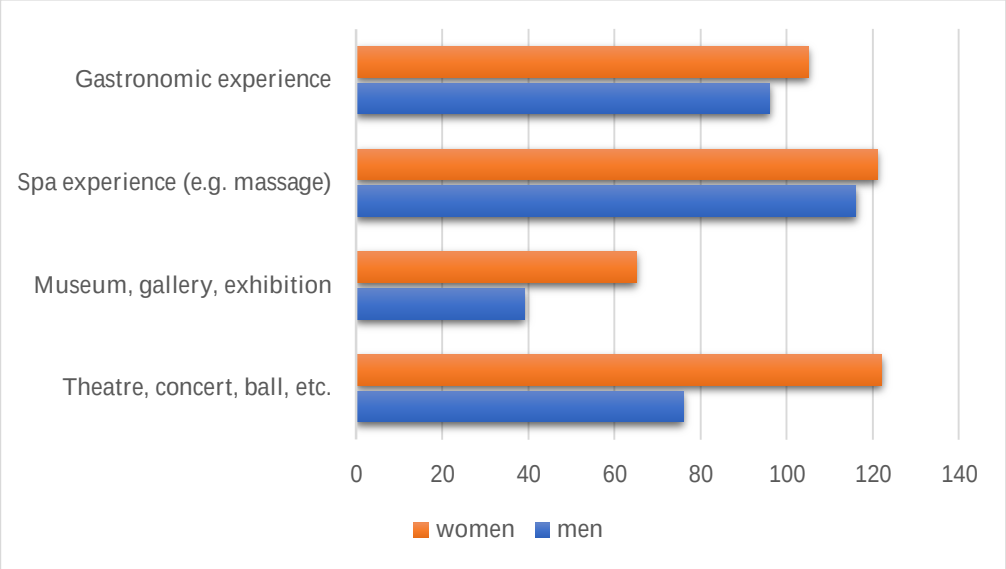

Figure 2. Specific interest in particular stay experiences by gender

The graph shows that women are more interested in cultural experiences such as theatre, concerts, balls but also exhibitions, galleries, and museums. Men are more interested in spa services, for example, in the form of massages or gastronomy-related experiences.

Another question in the questionnaire survey concerned the preference for using the services of travel agencies within the Czech Republic.

The graph shows that 59.09% of the respondents have not used and would not use the services of travel agencies in the future.29.83% of the respondents have not used the services of travel agencies but would not be reluctant to use a travel agency in the future.11.08% of the respondents have used the services of a travel agency for a domestic stay.

The interest in using travel agency services based on age examined the second tested relationship between age and use of travel agency for domestic stay, where the test criterion $\chi 2$ = 42.51096. Quantile chi-square (α = 0.05) = 3.841459.

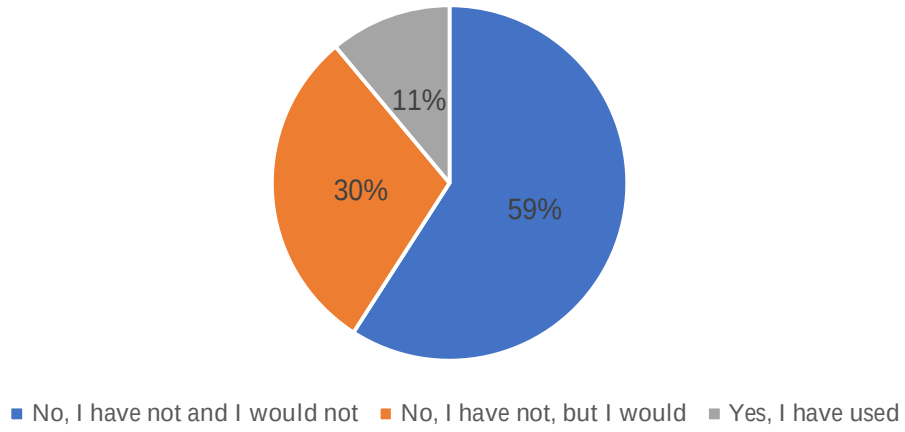

Figure 3. Preference for using travel agency services within the Czech Republic

Table 2. Hypothesis calculation

Test relation	Test criterion $\chi 2$	Quantile chi-square (α=0.05)	Sig.
Relationship between age and travel agency usage (domestic)	42.51096	3.841459	Yes

The test, under the second assumption (relationship), rejected the null hypothesis H_0 at 0.05% level of significance and the alternative hypothesis H_1 is accepted, which states that there is probably a relationship between age and the use of a travel agent to make a domestic stay. Specific interest in the use of travel agents by age was also part of the questionnaire survey (see Figure 4).

The graph shows that the age group 55 and older has used a travel agency the most. There is a high level of interest in using a travel agency in the 55-64 age group in the future. For a change, the lowest interest in the possibility of using a travel agency is observed in the 35-44 age group.

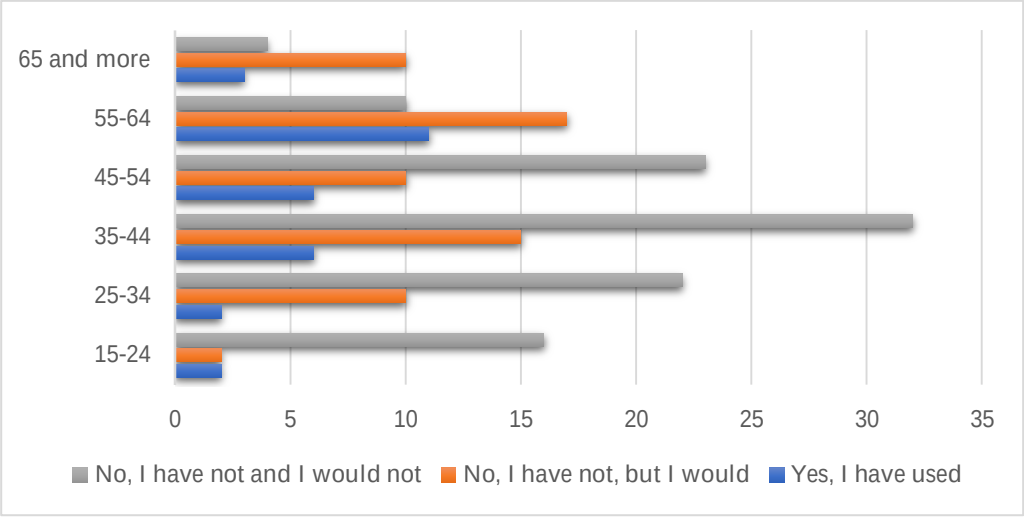

Figure 4. Specific interest in using travel agencies by age

4. Discussion

The COVID-19 pandemic has hit segments of the hotel industry in the Czech Republic very hard. The trend in recent years for hotel establishments has been to visit for short stays. Selected hotels follow this trend with a domestic clientele, which means these clients are more likely to seek extended weekend stays that are related to an experience. The questionnaire survey found that the most preferred experience is associated with a spa treatment such as massage or spa baths. This type of experience is preferred by over 67% of respondents. More than 57% of the respondents see this experience in a visit to a hotel, restaurant or café, where the hotel offers free coffee or snacks to clients. Over 56% of respondents want a culture-related experience. Culture in this case means, for example, a theatre performance, a film show, a concert, or similar activity. There is less interest in visiting museums and galleries. The desire for an experience associated with hotel accommodation is also one of the new trends in the hotel industry, where this trend can be supported by institutions other than the hotel itself and can become important for the development of the city and the overall 'revitalisation' of the region. The choice of actual culture-related experience is likely to vary by gender. The pilot research also demonstrated statistical significance for the likelihood of a relationship between gender and the requirement for a cultural experience According to the first hypothesis, there is likely to be a relationship between gender and the requirement for a cultural experience to stay. Therefore, it is possible that men prefer a different type of experience than women. Based on semi-structured interviews with hotel management, questionnaire surveys and hypothesis testing, it is observed that women are more likely to be interested in cultural experiences in the form of theatre, concerts, balls or visits to galleries and museums. For men, there is an increased interest in spa experiences, for example, in the form of massages or gastronomic experiences. The choice of hotel also depends on other factors other than interesting experiences. According to research (Tiwari, 2023), reviews and ratings of other customers are also important. Social networks are equally important.

Many domestic hotels do not use travel agents for home stays. The survey found that more than 59% of the respondents have not used a travel agent for domestic stays in the past and would not use one in the future. Nearly 30% of the respondents have not used a travel agent but would not hesitate to use a travel agent in the future. More than 11% of the respondents have used a travel agency for a home stay. This result may be supported by the fact that travel agencies in the Czech Republic tend to focus on foreign tours and domestic tours are not offered in such numbers. The low interest in using travel agents may also be due to the fact that people know how to use online booking portals and thus book their stay themselves, often probably cheaper than with a travel agent. The interest in using travel agents is also likely to be age-related, for example, older clients may prefer to stay in a hotel arranged through a travel agent, who can often arrange transport for them, making travel easier and more convenient. Research by Aldao et al. (2022) found that tours are associated with generational demands and preferences. Their research also showed that flexibility is also important. Therefore, travel agents should tailor their offerings to the needs of travelers. The work has also shown with statistical significance the likelihood of a relationship between age

and travel agency. According to the second hypothesis, the probability of the existence of a relationship between age and the use of travel agencies to make a stay in the country was proved. Based on the questionnaire survey and hypothesis testing, the author observes that the highest interest in using travel agencies is among the age group 55 and above. The lowest interest in using travel agencies is observed in the age group 35-44 years. This may also be due to the fact that older people may prefer the convenience of having a travel agent arrange both their stay and often their transport. For the younger age group, it can often be more convenient to book a stay through apps on your mobile phone. Of course, this is just an observation, and in practice younger people may also prefer travel agencies and vice versa. According to Ivanov et al. (2021), there will always be a market for group travel.

5. Conclusions

Tourism is an important component of the economy, infrastructure, and cultural activities in the spa town. The COVID-19 pandemic has been confirmed to have had a significant impact on tourism in the Czech Republic and on the hotel and spa industry, which is fundamentally related to tourism. The hotel industry was - and still is - facing economic problems. Selected hotels have benefited from support programmes introduced by the Czech Government to mitigate the impact of the COVID-19 pandemic.

There is a shortage of hotel staff as they have preferred to work in other areas affected by the pandemic. As a result of the pandemic, domestic spa hotels were lacking foreign clientele and it proved advisable to target domestic clientele as well when formulating their offerings. Domestic clientele cannot cover all the financial losses due to the pandemic but can mitigate them. Prague still has the largest purchasing power in the Czech Republic, and therefore capital clients could, at least to some extent, replace foreign clients. It turns out that the most preferred type of stay is short-term wellness stays that are complemented by spa, cultural, or other experiences.

Within the spa industry, it may be appropriate to offer your packages and price lists to travel agents to make offers to self-payers. Spas are very often visited by seniors and one of the hypotheses in this pilot research showed that there is likely to be a relationship between age and the use of a travel agent to make a home stay. Travel agencies such as Cedok or Mayer and Crocus have Czech Republic and spa stays in their offer and could be suitable to present domestic spa stays to spa hotels. The survey will be applied to other regions in the future.

Conflict of interest: none.

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The Relationship of Education and Unemployment

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Abstract: Unemployment is a key factor of a country's economy. It significantly influences the characteristics of an economy´s operating process. The aim of our research paper is to study and analyze the unemployment rate in two European countries. Concretely, we have decided to examine the Slovak Republic and Czech Republic. The mentioned two countries have formed one state till 1st January 1993, when they started their own separate and individual existence and operation. We analyze the unemployment rate in the mentioned countries between 2014 and 2021. Also, we concentrate on the achieved educational level of the unemployed population. Our goal is to answer the question, whether the unemployment rate among people with a diploma, university degree has shown a rising trend during the studied time period, which means from 2014 to 2021.

Keywords: unemployment; educational level; university degree

JEL Classification: E24; I25; J64

1. Introduction

Unemployment is one of the most frequently mentioned terms and it is considered to be a key measure of the health of the economy. Unemployment in the macroeconomic sense expresses a part of the working-age population registered by the labor office, which is not working. It also refers to a situation on the labor market where people actively seeking a job are unable to find employment. Large range of factors can affect the development of unemployment. These can include for example demographic change, education level, age, active labor market policy (Petrušová et al., 2018). The phenomenon of unemployment is mentioned in the work by Kilimova and Nishnianidze (2018). They studied and stated the existence of a relationship between the level of education, gender and age structure on the example of several European countries and Russia. Flek et al. (2020) analyzed labor market prospects of unemployed people aged 50-65 in the Czech Republic and Slovakia. In contrast, this paper confirms the effect of the duration of unemployment on job-finding, while the impact of explanatory covariates (like education level, gender or household characteristics) is not significant. Older Czechs also face a lower probability of remaining unemployed. Stachová and Musilová (2019), relying on the partial results of correlation analysis, stated the existence of a relationship between the results of the secondary vocational education (i.e., skills required by the employers) and unemployment rate of graduates of secondary vocational schools in Bratislava and Banská Bystrica Regions. According to Teichler (2018) university graduates spend six months on average searching for a job after receiving their diploma. It can differ from 0 months up to one year. In Japan, students usually start seeking

a job in the final year of their university studies, while in south European countries, such as Italy or Spain students start to do it only after finishing the university. However, Green and Henseke (2016) stated in their work, that based on the economic theories of the dynamic labor market it is impossible to reach a situation without a mismatch in the employment and the educational level, since the market is in constant movement. In this case, the job seekers can be undereducated or overeducated and it can easily change with the dynamic labor market. Hojda et al. (2022) studied the factors influencing the wages of employees and their satisfaction. The mentioned factors were ex post analyzes about the faculty, the studied field and the extracurricular activities of the questionnaire samples.

The aim of the paper is to analyze the development of unemployment in Slovakia and the Czech Republic in the years 2014-2022. The analyzes are done from the aspect of the regional allocation and the achieved educational level.

2. Methodology

In the work "The Relationship of Education and Unemployment" we explore the relationship between education level and unemployment in two Central European countries, concretely the Slovak Republic and the Czech Republic. The selected countries were creating a common state, called Czechoslovakia, till 1993 January 1, when they were divided and started to operate as independent separate states. We have collected information from the data collections of the Statistical Office of the Slovak Republic and the Czech Statistical Office. The collected data is about the number of populations in each Slovak and Czech regions (CZSO, 2022b; STATdat, 2022c), the monthly average salary (CZSO, 2021c; STATdat, 2021c), and about the number of unemployed populations in the mentioned countries according to the level of their education. We examine the data at the level of 14 regions of the Czech Republic and 8 Slovak regions. The data collection was done in the time period, from 2014 to 2022. Moreover, our work concentrates on the comparison of unemployment rate in the mentioned two countries, based on the unemployed persons' regional allocation and the achieved educational level.

In our work we have used quantitative and even qualitative methods. As the qualitative method, we studied and analyzed domestic and foreign literature about the mentioned research area. Also, we used comparative research methods and descriptive research methods to process data. Also, we were working with secondary data collected from the national statistical offices. The following indicators of descriptive statistics were used: mean, standard deviation. Moreover, we have used the Hoover Index to compare the concentration of unemployed during the analyzed time period in each region of Slovakia and the Czech Republic.

The work titled "The Relationship of Education and Unemployment" is the continuation and at the same time the complement of the work: Labor Market Policy in the Slovak Republic and Hungary during the COVID-19 Pandemic (Bálintová et al., 2022a). In this work we analyzed COVID-19 effects on the unemployment rate in Slovakia and Hungary. In the future we are planning to analyze and work on the problem of unemployment rate further on in the Visegrad 4 countries.

3. Results

The primary objective of the research was to investigate the connection between education level and unemployment, and the aim was to study the correctness of the following statements:

S1: The growth of the number of unemployed is more intense in the Slovak labor market. The territorial distribution of the unemployed is also uneven both in Slovakia and the Czech Republic within the period from 2014 to 2021.

S2: There is an association between the level of education and unemployment rate: the share of people with a basic education level is larger among the unemployed than the share of people with advanced education within the period from 2014 to the second quarter of 2022 in both European countries.

The choice of the mentioned period was intentional. Considering the fact that some support programs from the 2014-2020 funding period will be extended, it represents the years of the last program period of the European Social Fund (ESF). One of the main goals of programs supported from the ESF during the mentioned period was to get more people into jobs. Although an evaluation of these programs is not carried out in this paper, it is important to see how the unemployment figures have changed during the years of their operation.

3.1. Unemployment and Educational Structure of Unemployed

The development of the number of unemployed during the analyzed period in Slovakia and Czech Republic has shown a similar trend (Figure 1).

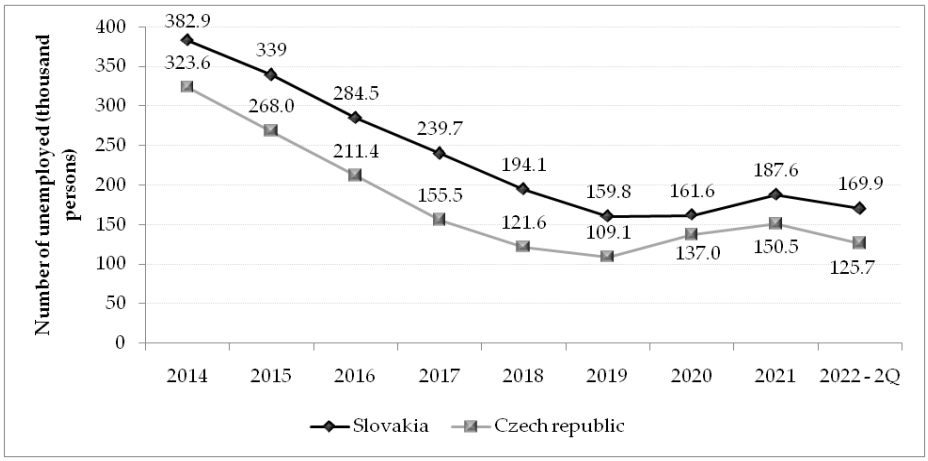

Figure 1. Number of unemployed in Slovakia and Czech Republic (STATdat, 2022a; STATdat, 2022b; CZSO, 2022a)

The number of unemployed gradually decreased in both countries during the years 2014-2022. The number of unemployed decreased intensively in Slovakia during the mentioned period. Among the unemployed, the number of job losers dropped on average 235.456 thousand persons each year in Slovakia. In the Czech Republic, the number of unemployed decreased annually by an average of 178.054 thousand persons. The standard deviation calculated from the data on the number of unemployed between 2014 and second quarter of 2022 was 82.433% (Slovak Republic) and 74.189% (Czech Republic). At the end of the period, as a result of the coronavirus epidemic,

among other things, the number of unemployed people began to increase again at the national and regional level. This was supported by the examination of the regional distribution of the unemployed. The analyzed data shows great regional diversity of unemployment both in Slovakia and the Czech Republic (Figure 2). The value of the Hoover index was 10.833% (Slovakia) and 12.872% (Czech Republic) in 2014, which indicates the relative extent of the differences between the territorial distribution of the two examined non-specific (absolute) indicators. Repeating the measurement for 2021, the value of the Hoover index was 21.766% (Slovakia) and 12.290% (Czech Republic). Thus, the degree of discrepancy between the regional distribution of the population and the number of unemployed continued to increase in Slovakia's regions. In the case of the Czech regions, the degree of deviations decreased slightly. We also measured changes in the spatial distribution of the unemployed over time using the Hoover index.

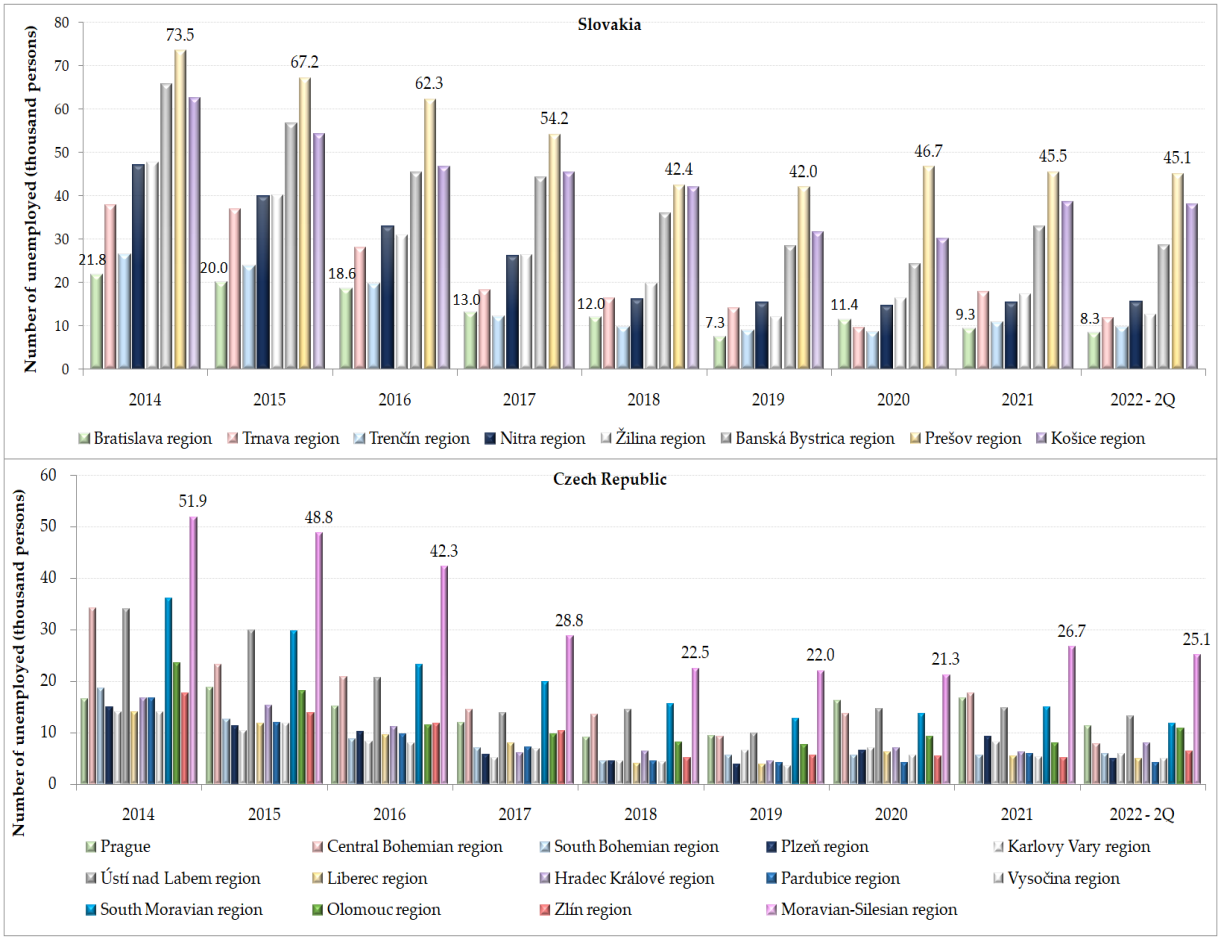

Figure 2. Territorial distribution of the unemployed in Slovakia and Czech Republic (CZSO, 2022a; STATdat, 2022a; STATdat, 2022b)

A dynamic interpretation of the Hoover index was also implemented to measure changes in the spatial distribution of the unemployed over time. The value of the indicator was 1.211% (Slovakia) and 1.450% (Czech Republic), which shows the change in the average territorial distribution of registered unemployed persons per year. The rate of change in the distribution of the unemployed per region was 1.211% (regions of Slovakia) and 0.828% (regions of the Czech Republic). The values show that in 2021, it was necessary to redirect nearly 2 percent of jobseekers from regions with higher unemployment data to regions that can be named as more attractive destinations for employers and

employees. The results can also be interpreted as the fact that the intensification of labor mobility would contribute to the equalization of unemployment data, and would also result in their reduction. In the case of the regions of the Czech Republic, the values of the index indicate less inequality in the distribution of the unemployed. We can say that statement no.1 was partially confirmed.

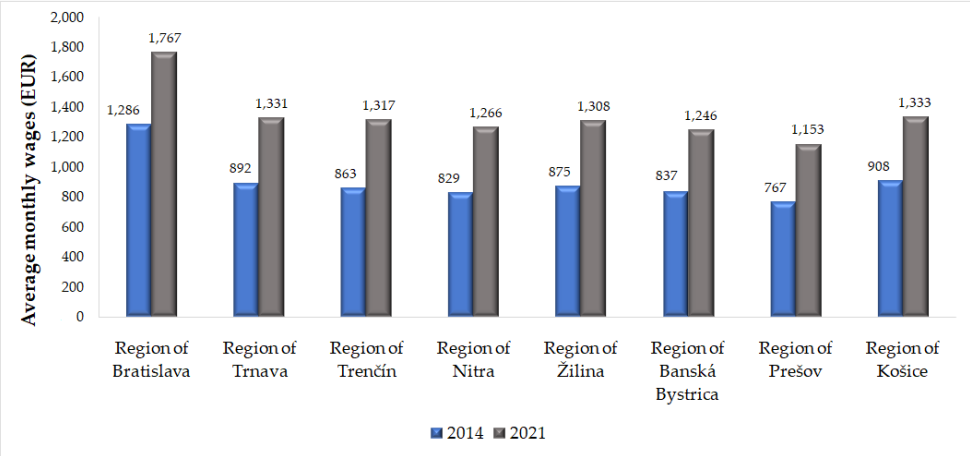

Figure 3. Average Monthly Wages 2014-2021, Slovakia (CZSO, 2021; STATdat, 2021)

Regional disparities are influenced by various macroeconomic factors, as unemployment rate and monthly average wages. On the previous graphs we are studying the trend of average monthly salaries in Slovakia and the Czech Republic in 2014 and 2021 (Figure 3; Figure 4).

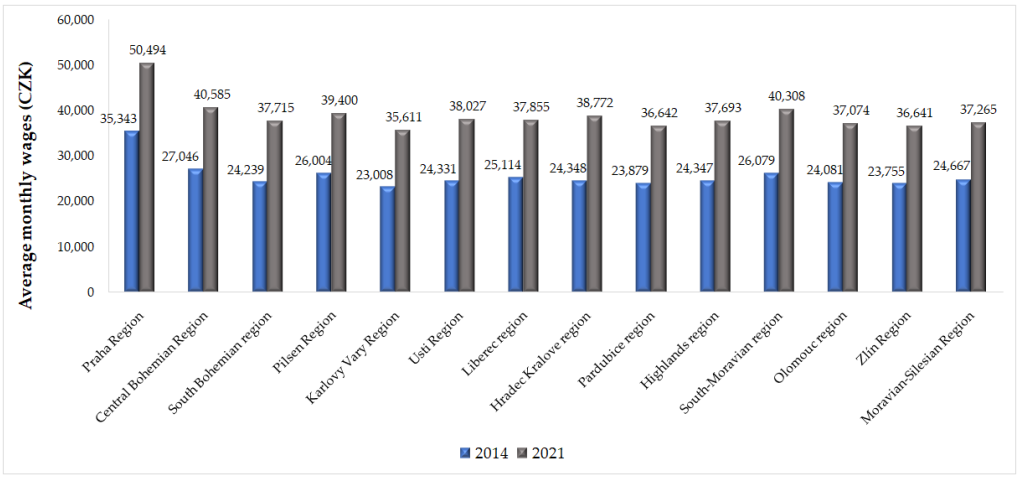

Figure 4. Average Monthly Wages 2014-2021, the Czech Republic (CZSO, 2021; STATdat, 2021)

We can observe a nationally and regionally unified rising trend on both countries. During the analyzed time period from the aspect of monthly average wages the problematic of regional disparities has not disappeared, is constantly present.

In Slovakia the average monthly nominal wage in 2021 has reached the highest level in the capital city, in Bratislava (Figure 5). While the lowest average salary was observed in Region Prešov, 1,153 EUR. In 2021, the lowest unemployment rate was in Bratislava region, where the monthly average salary was on the peak as well. In regions surrounding the capital city the monthly average salary was higher than in the regions situated further from it. Based on Figure 2. the highest unemployment rate was in Region Prešov, where the average monthly salary was the lowest in the country.

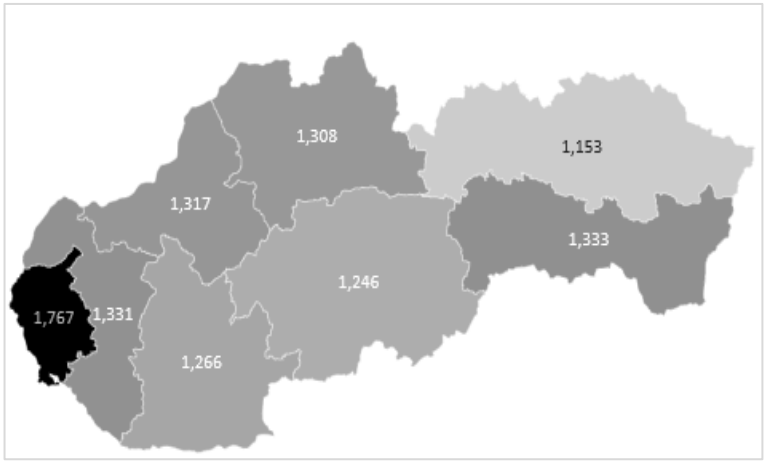

Figure 5. Territorial distribution of the average monthly salary in Slovakia – 2021 (CZSO, 2021; STATdat, 2021)

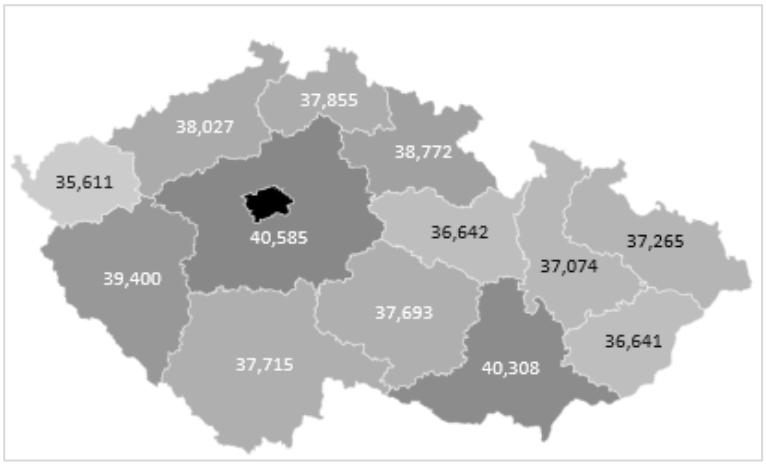

Figure 6. Territorial distribution of the average monthly salary in the Czech Republic – 2021 (CZSO, 2021; STATdat, 2021)

In the case of the Czech Republic similarly as in Slovakia, the highest monthly average gross wage was observed in the capital, in the Region of Prague, 50,494 CZK. While in Slovakia the lowest unemployment rate was observed in the region with the highest monthly salary rate, in the Czech Republic the lowest unemployment rate in 2021 was in Region Pardubice. However, here the monthly average salary was almost 15,000 CZK lower than in Prague Region. In the Czech Republic the highest unemployment rate was observed in the Central Bohemian Region. The mentioned region was the region with the second lowest monthly salary in the republic (Figure 6).

There are differences in the structure of unemployment between the two countries. Education structures of both countries are also different. Slovakia has a higher share of those unemployed people who completed upper secondary education with GCE (secondary school leaving examination). However, the share of unemployed with basic, pre-primary education or without education was also getting higher from 2018 to the second quarter of 2022. On the other hand, there is a higher proportion of unemployed people with lower secondary education without GCE in the Czech Republic as well as with tertiary education (Figure 7). In the examined period, the increase in unemployment among people with lower educational

qualifications can also be linked to the Covid-19 epidemic. The pandemic primarily affected live-labor-intensive sectors (for example hospitality, trade, manufacturing and construction) (Bálintová et al., 2022b), which sectors are also characterized by the employment of people with lower education. Adams-Prassl et al. (2020) also confirm that during the crisis caused by the coronavirus, the chance of job loss was significantly higher for workers with a lower (than college) education.

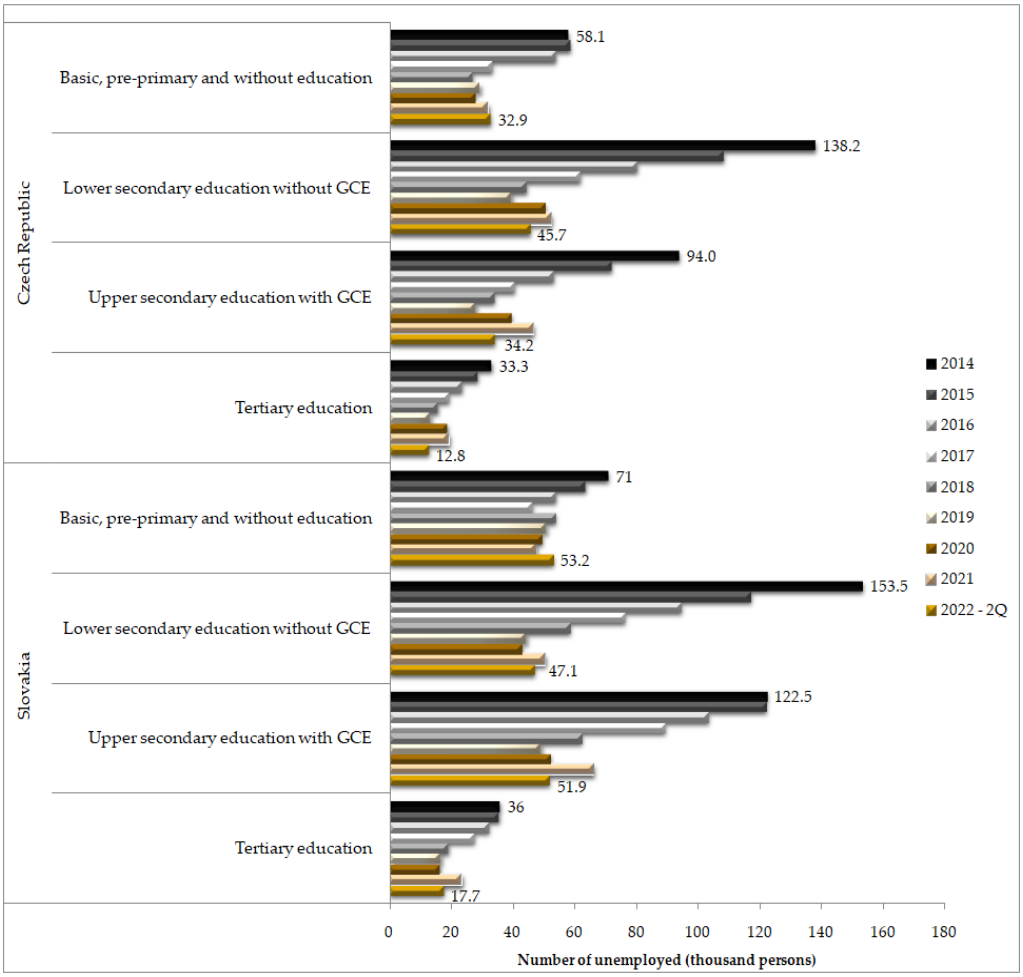

Figure 7. Education structure of unemployed in Slovakia and Czech Republic (CZSO, 2022a; STATdat, 2022a; STATdat, 2022b)

This finding is confirmed when comparing the proportion of people with basic, lower or upper secondary and tertiary education among the unemployed in both countries (Table 1). Based on the results of the analysis, the second statement was not confirmed.

In Table 1, we can perfectly observe the percentage rate of unemployed based on their educational level. While in Slovakia, in 2014, 40% of the unemployed population had lower secondary education without GCE, in 2022 only 27% of the unemployed had the mentioned educational level. In 2022 the group with the highest employment rate was among the basic, pre-primary and without education group. Which is very interesting is that during the analyzed 9 years the unemployment rate in the tertiary education level has grown as well. In Czech Republic, both in 2014 and 2022 the highest unemployment rate was in the lower secondary education without GCE.

Table 1. Educational structure of unemployed (CZSO, 2022a; STATdat, 2022a; STATdat, 2022b)

Country/Education level/Year (% of the total number of unemployed)		2022 2Q	2021	2020	2019	2018	2017	2016	2015	2014
Slovakia	Tertiary education	10.42	12.53	10.21	10.20	9.94	11.51	11.35	10.53	9.40
	Upper secondary education with GCE	30.55	35.24	32.36	30.60	32.15	37.30	36.38	36.05	31.99
	Lower secondary education without GCE	27.72	26.87	26.67	27.53	30.19	31.87	33.29	34.60	40.09
	Basic, pre-primary and without education	31.31	25.37	30.69	31.60	27.77	19.36	18.98	18.79	18.54
	Total	100.00	100.00	99.94	99.94	100.05	100.04	100.00	99.97	100.03
Czech Republic	Tertiary education	10.21	12.87	13.83	11.94	13.06	12.44	11.17	10.72	10.29
	Upper secondary education with GCE	27.22	30.95	28.93	25.20	28.02	26.13	25.22	26.90	29.06
	Lower secondary education without GCE	36.38	34.84	36.91	36.15	36.63	39.82	38.03	40.47	42.71
	Basic, pre-primary and without education	26.19	21.34	20.33	26.70	22.24	21.49	25.54	21.90	17.95
	Total	100.00	100.00	100.00	100.00	99.95	99.88	99.97	100.00	100.00

4. Discussion

In the research titled: The Relationship of Education and Unemployment, we placed our main focus on indicators as unemployment rate and educational level. We analyzed the mentioned two indicators in Slovakia and the Czech Republic in the time period: 2014-2022. In the research we were analyzing the unemployment rate in some educational level groups. Also, we have stated two statements, which are the followings:

- S1: The growth of the number of unemployed is more intense in the Slovak labor market. The territorial distribution of the unemployed is also uneven in both Slovakia and the Czech Republic within the period from 2014 to 2021 in both European countries.
- S2: There is an association between the level of education and unemployment rate: the share of people with basic education level is larger among the unemployed than the share of people with advanced education within the period from 2014 to the second quarter first of 2022 in both European countries.

With the help of our quantitative research, we can state that the first statement was partially confirmed. (Figure 2.). Similar results were obtained by Privara et al. (2018) who, based on data for 2015, researched the regional differentiation of unemployment in the case of the regions of Slovakia and the Czech Republic (primarily with regard to the factors influencing unemployment such as gender, age, education level). Focusing on the regional evolution of long-term unemployment as a specific form of unemployment, their research results showed a relatively favorable labor market situation in the majority of Czech regions

and in the case of Western Slovakia. On the contrary, in the Eastern Slovakian region, the high unemployment rate is a continuous problem, and there are high levels of inequality between some regions of Slovakia, as well as between Slovakia and the Czech Republic.

However, the second statement cannot be confirmed, which means that the share of people with basic educational level was not larger than the other educational level groups. Ionescu (2012) stated that a high participation in education is not clearly or necessarily associated with a higher employment rate. So, based on her statement, employability is not necessarily in correlation with the educational level. Similarly, Kobylińska et al. (2017), claimed the reason for the unemployment of young European, primarily Polish, workers in the existence of graduates' purely theoretical knowledge. The degradation of higher education, its easy accessibility and the high number of university graduates increase unemployment among the representatives of the millennial generation even more. They note that, unlike what was experienced before, university education is no longer considered a key factor in the labor market. Experience and the existence of the so-called "soft skills", which do not require higher education, will be key factors. In contrast, according to Musilova and Stachova (2017), it is clear that higher education improves the labor market prospects of Slovak workers, and that those with higher education are more likely to keep their jobs in times of economic difficulties. Based on their research results, people with secondary education are in a more difficult labor market situation than young workers with higher education.

In the following time period, we would like to extend our research on more countries, concretely on the countries of the Visegrad 4 countries. These analyses could give us a better overview of the area. Moreover, we would like to concentrate on graduate unemployment and analyze it more into detail.

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Conflict of interest: none

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The Role of Employer Branding in Choosing a Workplace in South-West Slovakia

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Abstract: Nowadays, it is typical that not only employees compete to get a specific job, but also competition has developed between companies so that the most talented employees choose them and work for them. However, acquiring the most talented and most suitable employees for a given position requires serious energy. One potential tool for this is employer branding. In our study, we would like to assess the role this plays in the choice of workplace in South-West Slovakia. To this end, we conducted primary research involving 150 respondents. During our research, we formulated three hypotheses, which were analyzed in the SPSS statistical program. Based on our research results, even though employer brand building can be attributed to a costly marketing activity, it will definitely pay off after a certain period of time, as factors that are important to the respondents during the job search can also be found in the elements of the employment value proposition defined in the literature. The majority of respondents consider it important that the company has a good reputation as an employer, and it is also characteristic of them that they would prefer to work for a company with a strong employer brand.

Keywords: employer branding; job search; labor force

JEL Classification: E24; J21; J24

1. Introduction

The brand is of great importance in the life of the company. It is a value that, if handled creatively and competently by marketers, has a great impact on the company's profitability (Kotler & Keller, 2013). Levine (2003) reflected on the brand in such a way that anyone or anything that has an influence on the consumer can form the brand.

The concept of employer branding was first discussed by Ambler and Barrow, who defined it as the set of functional, economic and psychological benefits derived from employment and identified with the employee (Ambler & Barrow, 1996). Armstrong and Kotler (2006) stated that employer branding is the cultivation of a specific organizational image through the development of a brand reputation that is not only related to the core business but also to the widely accepted employer reputation.

The international competitive environment forces businesses to seek strategic advantages in non-traditional areas such as human resources and organizational culture (Kargas & Varoutas, 2015). Since all companies strive for the highest profit, they must pay great attention to acquiring the most suitable and valuable workforce. Therefore, it is

important to develop a strong organizational identity that conveys the company's values and distinguishes it from its competitors (Martic, 2022).

Nowadays, employer branding is of great importance. A positive employer brand increases recruitment success, employee engagement and recruitment. Nowadays, the decisions of employees are characterized by the fact that they choose an employer based on the same conditions as they choose products and services. This is especially true for members of the Y generation, who do not view their work solely as a means of earning money, but also want to enjoy it (Kajos & Bálint, 2014).

Biswas (2013) distinguished four elements that jointly create the employer brand: performance management, culture and environment, brand image and reputation, and employment package. Employer branding is based on experience. According to Edwards (2010), values and impacts are created when companies carefully manage their employment experiences. We call this employment experience an employment value proposition (EVP). In 1999, the Corporate Leadership Council released a report emphasizing a strong EVP. In addition to the opportunity to work for a company with an employer brand, these offerings include the level of compensation and benefits, work environment, work-life balance, and company culture. It is important for a company's EVP to meet various criteria, to be honest, clear, inspiring and unique. The EVP is a kind of declaration in which the company can communicate its benefits to the employees.

The most important building blocks of a successful employee value proposition include compensation (salary, increases, fairness, timelessness, promotions), benefits (freedom, security, flexibility, development, home office), career (stability, consultations, evaluation, career building, feedback), the work environment (challenges, recognition, independence, understanding, balance) and the culture (understanding of goals, colleagues, support, trust, team spirit) (Talentlyft, online).

Not all companies are willing to invest money in employer branding because the costs can seem high compared to the immediate returns. After all, building a strong employer brand requires a company to spend money on research and creative development, and increase the workload of already busy departments. Including human resources and marketing (Kajos & Bálint, 2014).

Based on the research of Moroko and Uncles, there is a correlation between how well-known and easily noticeable the company is, as well as the extent to which it can be considered a relevant employer and how it can be distinguished from its direct competitors (Sánta, 2020 based on Moroko & Uncles, 2008). To build a strong employer brand, we need a certain amount of time in order to get the right results. It is a longer process that has great benefits that are worth waiting for. Hollensen (2007) characterized employer branding as a long-term process, the purpose of which is to plant a positive image in people's minds about the company that attracts them. Sullivan (2004) defined employer branding as a long-term strategy that targets three distinct groups:

- existing employees and their effective management,
- future or attracted sought-after employees,
- third parties related to the company and interested in cooperation.

Backhaus and Tikoo (2004) defined the employer branding process in three steps. The first step is to create a value concept that embodies the brand. The organization should conduct thorough research in this step, as it involves developing propositions that will become the central message. The second step is the marketing of this value and brand. The target group is made up of employees, so it is important that the brand's message is attractive to them. The final step in the process is the internal marketing of employer branding. Keeping the brand promise, introducing it to new employees, and incorporating it into the organizational culture.

Kozlowski (2012) divided employer branding into external employer branding and internal employer branding, which companies can implement in different ways.

- External employer branding – The company must be visible in the target markets of the employees using a multidimensional method. The company needs an excellent website that includes the culture, career opportunities, and advertises why the employee should choose the workplace. This type of branding is mainly for professionals, students and graduates. External branding can fulfill two functions. It primarily performs an image-creating function, the main task of which is to increase the brand awareness of the candidates, inform the labor market about the company and its activities, as well as the advantages of working in the company. Secondarily, it has a recruitment function, which is responsible for finding potential, talented workers to fill job vacancies.
- Internal employer branding – The second is the internal approach, during which the company turns its employees into “protectors”. Internally, they create powerful branding based on the employee experience, making employees love the workplace. (Kunerth & Mosley, 2011; Gaddam, 2008).

Employer Brand International CEO Brett Minchington (2006) has created a roadmap to help companies develop their employer brand. The plan consists of four parts: concept, design, integration and evaluation.

- Conceptual phase – First, define the boundary scope of the employer brand project. Next comes the identification of those involved, followed by the completion of internal and external research and the evaluation of the results. The main responsible department of the phase is HR.
- Designing phase – In this phase, the identity and image of the employer brand is defined, which is reviewed and evaluated by the company's top management.
- Integration phase – Here, HR connects the employer brand management system with the people management guidelines and practices, and together with this, the communication plan for the employer brand is created.
- Evaluation phase – The metrics defined by the HR functions show a picture of the return on investment, and these results are jointly reviewed with management (Biswas, 2013).

According to Biswas (2013), measures with employer branding are still emerging. It is difficult to show tangible results within a short period of time from the investment. The most frequently used offers in articles published by researchers on the topic include:

- conducting a survey among employees, which can be used to assess employee satisfaction,
- measuring the skills, abilities, and knowledge of incoming employees, which can be used to determine productivity at the individual level,
- university survey on the various campuses.

Every employee chooses a workplace based on different criteria. It is essential for companies to know these job selection aspects in order to successfully attract the workforce. Since it is impossible for us to conduct worldwide research on the topic, we would like to gain a broader insight into the topic using data from the Randstad Award, which is the world's largest employer survey.

During the successful branding process, it is essential to get to know the current image of employers and the employee side, and to explore the differences between the value propositions requested by employees and those offered by companies. Based on the research, the ranking of the three most important factors influencing the choice of workplace is unchanged compared to previous years. For 73% of respondents, salary remains the most important evaluation aspect, followed by a pleasant working atmosphere (61%) and long-term job security (56%). Again, work-life balance and the financial stability of the company are at the forefront of the aspects that influence employers' judgments. The significance of both the flexible schedule and the interestingness of the job position has increased, and the role of the company's general reputation and social responsibility has also increased (Randstad, 2020). With this ranking in mind, it is worthwhile to develop the employer brand.

A lot of people see their work as a constraint that only provides them with financial security and a living for their families. However, there are also individuals who look at their workplace from a different perspective. They see their work differently, mainly putting career and personal development first. Both views are understandable, but the difference between them is that financial security satisfies the individual in the short term, while career building is a longer and slower process. Those who set goals for themselves and work for their personal development will be more effective in their work, and this will pay off in the long run. Job choice preferences are crucial for an individual in choosing the right job (Dukar, 2021).

Currently, many companies are struggling with a labor shortage, and it is certainly not an easy task to find the right employees. The Y generation is completely different from its predecessors, it prefers different aspects, but a successful company must know the job selection needs of the young generation in order to successfully attract them. However, it is also important to retain them. A significant part of the young generation is more open to new things and is not afraid to even change jobs in order to achieve their goals. In many cases, if the employees' idea of the given job position differs from reality, they can switch without hesitation. Members of Generation Y perceive work as an experience. They look for opportunities for their own self-realization in companies. They are characterized by thinking, they want to develop quickly, and a career abroad is attractive to them (Libby & Mark, 2010). Generation Z is already more goal-oriented, more proactive and open to new things, they do

not doubt their abilities. With the help of the virtual network, they can perform their tasks even from the other side of the world, they are not tied to a specific location. They no longer represent the traditional work culture, they are building a completely new world (Gyarmati, 2017).

2. Methodology

The aim of the research is to reveal the role of the employer brand in the choice of workplace in South-West Slovakia. In today's uncertain world, we would like to know what effect the employer brand has on people, and what preferences they have, by which they choose a workplace. During our research, we conducted primary research. Primary research is one of the most popular research methods, during which one's own information collected for a specific purpose is analyzed (Boncz, 2015). The research was carried out using a questionnaire, which was edited using Google Forms. We distributed our online questionnaire using the snowball method. We sent the questionnaire to 50 of our friends, who were asked to forward it to at least 5 of their friends living in South-West Slovakia. The questionnaire could be filled out for two months. During this time, 150 responses were collected. The hypotheses formulated during our work were the following:

- H1: In terms of gender, a significant difference can be shown in how important the employer's reputation is to them.
- H2: In terms of gender, a significant difference can be shown in how important the brand is to them in general.
- H3: In terms of gender, a significant difference can be shown in whether they would prefer to work for a company with a well-established employer brand.

The received data were analyzed using Microsoft Excel and the SPSS statistical program.

3. Results

In the first half of our questionnaire, we asked demographic questions. The first question was used to reveal the gender of the respondents, which helped us to get information that a higher number of women were involved in our research, making up 67% of the respondents. Men were present with 37%.

The questionnaire was mostly filled out by young people in the 18-25 age group. This age group was represented by 58 people with 39%. 30 (20%) of the participants aged 26 to 35 filled out the questionnaire, while 26 (17%) of those aged 36-45 filled out the questionnaire. There were 30 people over 46, with 20%, and 6 people over 56 were present in a relatively smaller proportion (4%). This means the majority of the answers came from members of the Z (under 27) and Y (27-42) generations.

After clarifying the gender and age of the respondents, we also wanted to gain an insight into their educational qualifications. The highest number was represented by those with a secondary education at 67%. This was followed by persons who graduated from college or university (27%). Respondents with primary school education had the smallest proportion, with 6%.

The other questions in the questionnaire can be divided into two groups: workplace choice and brand. The first question about job search focused on how the respondent searches for work.

Nowadays, information is transferred in many different ways. This can also be an advantage when looking for a job, as there are many options that companies can use to advertise their vacant, new positions to employees. In today's modern world, this flow of information takes place mainly on online platforms. Paid advertisements on these online platforms are highly effective in reaching potential employees. 37% of the respondents use job portals to find a job. 15% search for new jobs through various Internet advertisements, while 7% of those surveyed search for new jobs in Facebook groups. A large number of respondents apply for a certain position directly by contacting the employer (29%). Nowadays, employment agencies are becoming more and more popular, but only 6% of our respondents use their services.

In the next question, we sought the answer to what factor motivates the respondents when choosing a specific workplace. The most popular aspect was salary, with 43%. In second place was long-term job security, which was indicated by 27%. Career-building opportunities are preferred by 17%, while flexible working hours are preferred by 13% when choosing a new workplace. This is mostly typical of the Y and Z generations, who already change jobs more easily, prefer flexible working hours, and see work not only as a constraint, but as opportunities for development and career building.

After that, we assessed how important the reputation of a particular employer is to the respondents. Respondents had to indicate this on a five-point Likert scale (1 – not important at all, 5 – very important). 37% of respondents consider the employer's reputation very important and another 33% consider it important. For 18% of respondents, this is neutral. 9% believed that the good reputation of the employer is less important, and 3% indicated that it is not important at all.

Our first hypothesis concerns whether there is a significant relationship between the respondent's gender and how important an employer's reputation is to the respondent. In order to test the hypothesis, we prepared descriptive statistics (Table 1) and performed analysis of variance (ANOVA) (Table 2).

The reason for this is that since the gender of the respondents is a nominal variable and the degree of importance measured on the Likert scale is a scale-type variable, based on Sajtos and Mitev (2007), in this case, an ANOVA analysis must be performed to test the relationship between them.

Table 1. Hypothesis H1 – Descriptives

How important is the reputation of a workplace to you?								
				Std.	95% Confidence Interval for Mean			
	N	Mean	Std. Dev.	Error	Lower Bound	Upper Bound	Min.	Max.
Man	55	3.85	1.113	.150	3.55	4.16	1	5
Woman	95	3.96	1.091	.112	3.74	4.18	1	5
Total	150	3.92	1.096	.090	3.74	4.10	1	5

Based on the values in Table 1, the reputation of a company is more important to women than to men, however, Table 2 does not confirm the H1 hypothesis, as the significance level (Sig.) of the probability of test F is 0.580, i.e. greater than 0.05. We can accept the null hypothesis and reject the H1 hypothesis.

Table 2. Hypothesis H1 – ANOVA

How important is the reputation of a workplace to you?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.372	1	.372	.308	.580
Within Groups	178.668	148	1.207		
Total	179.040	149			

In the next question, we have already turned to the brand, employer branding.

Since the brand is present in all areas of our everyday life, we asked how important the brand is to the respondent in general. The respondents again had the opportunity to express their opinion on a five-point Likert scale. By marking a point of five, the respondents indicated that they consider the brand very important in general, which made up a total of 24% of the incoming data. 29% consider the brand important, and 31% gave a neutral answer. For 7% of respondents, the brand is less important, and for 9% it is not important at all.

Our second hypothesis related to whether there is a significant difference between genders in how important the brand is to them in general. Due to the type of the two variables, we also performed an ANOVA analysis (Table 4), before which we prepared the descriptive statistics (Table 3).

Table 3. Hypothesis H2 – Descriptives

How important is the brand in your life in general?								
				Std.	95% Confidence Interval for Mean			
	N	Mean	Std. Dev.	Error	Lower Bound	Upper Bound	Min.	Max.
Man	55	3.67	1.139	.154	3.36	3.98	1	5
Woman	95	3.42	1.225	.126	3.17	3.67	1	5
Total	150	3.51	1.197	.098	3.32	3.71	1	5

Table 4. Hypothesis H2 – ANOVA

How important is the brand in your life in general?					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.206	1	2.206	1.546	.216
Within Groups	211.267	148	1.427		
Total	213.473	149			

Based on the results, the brand is generally more important in the life of men than in the case of women, but the analysis of variance did not show a significant relationship in this case either (0.215>0.05), therefore we also reject the H2 hypothesis.

In our questionnaire, we also used the option of an open question, where our respondents could express their opinion regarding the employer brand. We were wondering if they knew any companies with a strong employer brand. 72 of the people interviewed answered (48%) that they did not know such companies, and the other respondents gave examples. Most people mentioned the new and popular company About You. In addition, banks such as OTP, Tatra Bank, Uni Credit and Allianz were mentioned. Among the answers we can also find famous companies such as Volkswagen, Schindler, MOL, Wertheim, Apple, Dell, IBM, Philips.

In the next question respondents could come across the definition of the employer brand and, based on this and with the help of their previous knowledge, they could decide whether they had ever heard of the employer brand. 57% answered that they had already heard of it or were familiar with it, but there were also those who were not familiar with the employer brand (43%).

We asked our respondents how important they consider certain factors (Figure 1) in building a company's employer brand. These factors can provide different benefits to employees and make their work more pleasant.

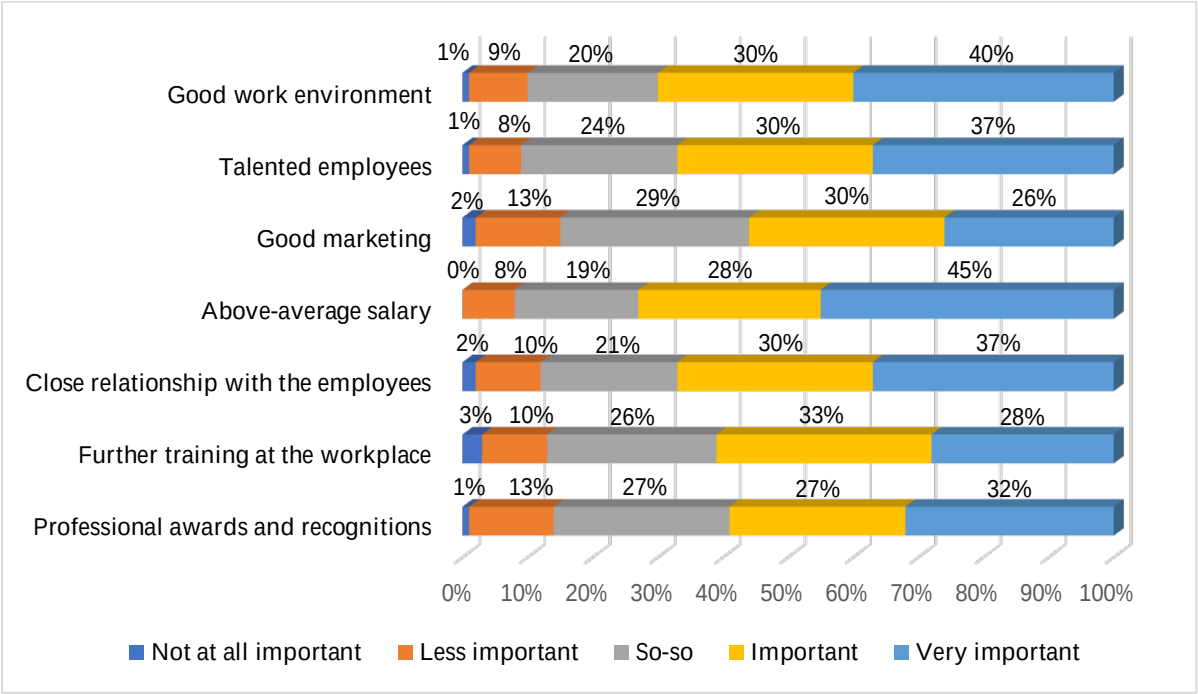

Figure 1. How important do you consider the following factors to be in properly building a company's employer brand?

The respondents found it essential that when building a company's employer brand, the employer rewards the employee with an above-average salary. 45% marked this factor with 5, and there was not a single person who rated it with 1. Relatively many, 40%, marked option 5 for the homely work environment, which can make gray weekdays easier. It is essential for them to create a kind of comfort zone in their work environment. When it comes to attracting talented employees, 37% of our respondents agreed that it is outstanding in properly building a company's employer brand. They also felt the same way about the close relationship

between the company and its employees. This is an essential factor in the operation of a company. A good, harmonious relationship can speed up the work process, improve employees' positive attitude to work, and avoid workplace conflicts. The evaluation of the factor of professional awards and recognitions was also positive. 32% consider this very important when building the employer brand. These recognitions and awards can also stimulate an employee and motivate them to increase their performance. The sum of the number of very important marks in the evaluation of further training at the workplace did not reach 30%. Good marketing received the lowest rate, the very important classification with 26%. Here, 15% of the respondents consider this factor to be more or not at all important in employer branding. Advertisements contribute greatly to the visibility and distribution of a brand. A well-constructed advertisement attracts consumers.

The individuals participating in the research were also asked whether they would prefer to work for a company with a well-established employer brand. 82% of respondents would prefer to work for a company that is more popular. Companies should therefore strive to build a positive employer brand, since, as it turned out from the literature review and research results, a strong employer brand increases recruitment success, employee engagement and retention.

By examining our hypothesis H3, we wanted to answer the question of whether there is a significant difference in terms of the gender of the respondents in whether they would prefer to work in a company with a well-established employer brand. Since both variables are nominal, the Chi-square test must be used to examine their relationship (Table 5).

Table 5. Hypothesis H3 – Chi-Square Test

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.158a	1	.691		
Continuity Correctionb	.031	1	.860		
Likelihood Ratio	.159	1	.690		
Fisher's Exact Test				.826	.435
Linear-by-Linear Association	.156	1	.692		
N of Valid Cases	150				
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.90.					
b. Computed only for a 2x2 table					

As the result of the test did not show a significant result ($p>0.05$), we rejected the H3 hypothesis, so the respondent's gender does not affect whether they would prefer to work in a company with a well-established employer brand.

4. Discussion

The aim of our study was to reveal the role of the employer brand in the choice of workplace. To this end, we conducted primary research involving 150 people.

Based on the research results, the job search mostly takes place online. The majority of respondents browse online job portals, internet ads or Facebook groups to find a new job. When choosing a workplace, the main motivating factor is salary, followed by long-term job security, the opportunity to build a career, and then flexible working hours. 70% of respondents consider it important or very important for a company to have a good reputation as an employer. The mean given by women was slightly higher than that of men, however, based on the results of our hypothesis analysis, the difference is not significant. More than half of the respondents consider the brand to be generally important or very important in their lives. In this question, unlike the previous one, the mean of men was higher, but the difference between the sexes is not significant in this case either. During our research, we were also interested in which specific companies have a strong employer brand according to the respondents. The respondents listed companies such as Volkswagen, Schindler, MOL, IBM.

According to their own admission, 57% of the people involved in the research are aware of the concept of the employer brand. In their opinion, the following play an important role in building the employer brand: above-average wages, good work environment, talented employees and building a close relationship with employees. 82% of respondents would prefer to work in a company with a strong employer brand. No significant difference between the sexes could be identified.

According to Kajos and Bálint (2014), not all companies willingly invest money in employer branding, as it usually involves high costs and a long payback. Nevertheless, our research results also support that the factors that are important to the respondents during the job search are also important for them to build a strong employer brand. These can also be found among the elements of the employment value proposition defined by Edwards (2010) and the Randstad (2020) survey.

The limitation of our research was the size of the sample, more detailed analyzes can be performed with a higher number of responses. During our research, we did not conduct an analysis based on sectors, on the basis of which the results could be more specific. Therefore, a possible future direction of the research is to expand the size of the sample and examine how important the employer brand is in a given industry with the help of analyzes broken down by sector.

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Village Fund in Poland During Covid-19

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Abstract: The article discusses the preliminary results of a study on changes in the scale and directions of spending from the village fund during the Covid-19 in 2020-2021. The response of local governments and residents to the crisis caused by the pandemic is, in the case of the village fund, a manifestation of shared responsibility for the financial situation of the local government, which results from the idea of public participation. The article analyses the structure and size of expenditures in the period 2018-2021, considering the directions of expenditures both nationally and in individual voivodships (regions). The results of the research indicate that despite a decrease in the number of rural municipalities in which the village fund functioned during the pandemic period, this was not a mass phenomenon. In addition, there was no significant change in the structure of expenditure in 2020-2021 compared to 2019.

Keywords: village fund; covid-19; public participation

JEL Classification: H76; J48

1. Introduction

Village funds as a tool of public participation have become one of the more popular solutions in Poland for activating small local communities in rural areas. The main advantages of this solution include the directness of decision-making through deliberation and the co-creation and co-production of public services. Thus, they are part of the implementation of the concept of good governance and, as part of it, increasing public participation (European Governance - A White Paper, 2001). Since 2009 (when regulations governing the creation of village funds were formally established), the number of rural municipalities in which local authorities agreed to set up such a fund has steadily increased.

In practice, processes of consultation of local authorities' decisions with the inhabitants were already possible before, but the opinion of the inhabitants was usually not binding (Łukawiak, 2020) and it was only by regulating the procedures and giving a binding character to the decisions taken regarding the direction and form of spending of funds by local communities within the framework of village (sołecki) funds that a new dimension of the relationship between citizens and those who govern them was created in Poland. It should be noted that, according to S.R. Arnstein's classic ladder of participation (Arnstein, 1969), the introduction of village funds, involves the actual surrender of power (with significant limitations) over a dedicated part of public funds (Bednarska-Olejniczak et al., 2020). It is thus a crossing of the boundary between sham participation (consultation) and real participation

(partnership). Research to date has focused firstly on the construction of the village fund mechanism itself (Wójcik, 2014; Łukowiak, 2020). Secondly, on its scale, scope and financial implications for municipalities (Kaczurak-Kozak, 2017; Feltynowski, 2020). Thirdly, they focused on the differences and similarities to participatory budgeting (Owsiak, 2016; Pięta, 2020; Leśniewska-Napierała & Napierała, 2020). Next, the impact on local communities (Głod-van de Sanden, 2017; Gulińska & Składanek, 2017; Ptak, 2015; (Bednarska-Olejniczak et al., 2021) and the fit of village funds in achieving the SDGs goals (Bednarska-Olejniczak, et. al. 2020) have also been addressed. One of the most recent studies was devoted to the analysis of the variability of the directions of spending of SFs indicated by the inhabitants of municipalities (Olejniczak & Bednarska-Olejniczak, 2019b; Sześciło & Wilk, 2018; Olejniczak & Bednarska-Olejniczak, 2019a; 2022). In contrast, no analysis has appeared in the literature to date indicating the impact of the Covid-19 pandemic on changes in the number of municipalities, the amount of funding and the direction of expenditure from village funds. This is partly due to the design of the village fund mechanism (decision-making one year in advance of expenditure implementation) and partly due to the availability of data.

It should be noted that the introduction of a village fund in a municipality is not mandatory. The Covid-19 pandemic has disrupted the financial management of municipalities - in particular affecting their revenue and increasing the expenses associated with the need to counter the risks associated with it. This raises the question of whether, and to what extent, local governments and residents have reduced spending related to the operation of village funds, and if they have maintained their operation, have the directions of spending changed? The available data covers the year 2021, which also affects the results of the study. This is because it is significant here that the adoption of a resolution to allocate the village fund for 2021 (or to keep the earlier one in force) occurred literally on the eve of the outbreak of the pandemic in Poland (March 2020), and the communities' applications for expenditure were already submitted during the pandemic (until 30 September 2020). This indicates that municipal councillors should have anticipated the impending crisis (on the basis of information from other countries), and residents co-determining municipal expenditure at the time of the decision (and thus taking joint responsibility for the finances of the municipality) should have been aware of the seriousness of the situation.

The paper therefore raises the following research questions:

RQ1. Was there a change in the number of municipalities in which village fund expenditure was implemented nationally and by region during the pandemic period?

RQ2. To what extent has the scale and structure of village fund expenditure changed nationally and in individual regions?

The rationale for posing such questions is based on the experience of cities in which a participatory budget (which is also a tool for public participation) was in operation, some of which abandoned its continuation during the pandemic.

The problem described is also important from the point of view of the theory of public participation as an observation that in part makes it possible to assess the sense of responsibility of residents for the finances of the municipality, because to a large extent (due to the timeframe of the procedure for adopting the village fund, and the limitations on the possibility of

modifying the adopted expenditures within the fund) it was the residents who made the final decision on the scale and directions of spending in 2021 the village fund.

2. Methodology

According to data from the Ministry of Finance for the period 2009-2022, by 2019, the number of municipalities that had decided on the possibility of setting up village funds in their area was steadily growing, reaching more than 74% in 2019. Between 2020 and 2022, this trend reversed. It should be noted that the issue of a local law act in the form of a council resolution alone does not guarantee the creation of a SF in a municipality in the following year. Only an analysis of the actual expenditure of the municipalities makes it possible to conclude that the village fund has been functioning in practice in a given municipality. For this reason, the research used data available from the Local Data Bank of the Central Statistical Office (GUS) on the volume and directions of expenditures from the budgets of municipalities allocated to the implementation of tasks within the framework of village funds in the years 2018-2021. The level of detail of this data makes it possible to diagnose the main areas/directions of expenditures, but it does not make it possible to obtain detailed information on individual distributions of expenditures. Thus, the analysis carried out included, firstly, an analysis of changes in the number of municipalities (nationally and regionally) that implemented the village fund in successive years, and secondly, a comparison of the scale and main directions of expenditure nationally and regionally.

3. Results

3.1. Essence of the Village Fund from a Research Perspective

To improve the efficiency of municipalities located in rural areas, it is possible to set up auxiliary units – sołectwo. Their scope is usually the area of one or more villages. The main tasks of the sołectwo are cooperation with the municipal authorities in the areas of health care, social welfare, education, culture, physical culture, public order and fire protection. To fulfil these tasks, a pool of funds may be set aside in the municipal budget for individual sołectwos, the allocation of which is decided by the inhabitants of the village. These funds constitute the village fund, which is one of the most common forms of public participation in Poland. The procedure for its establishment and disbursement is described in the Act on the Village Fund of 21 February 2014. The aim of the Act was to ensure that villagers can decide independently and collectively about their environment and quality of life. Village funds expenditures usually account for about 1% of total municipal expenditures (Figure 1), and their main source is the budget of the municipality and partial refinancing of expenditures from previous years from the state budget.

In practice, the decision to set aside a village fund for the following year may be taken each year by 31 March of the year preceding the year in which the funds are to be spent, but it is permanent in nature, i.e. it is in force in subsequent financial years until the Municipal Council adopts a resolution not to approve the setting aside of the village fund. A resolution not to express consent for the creation of a village fund applies only to the financial year following the year in which it was adopted.

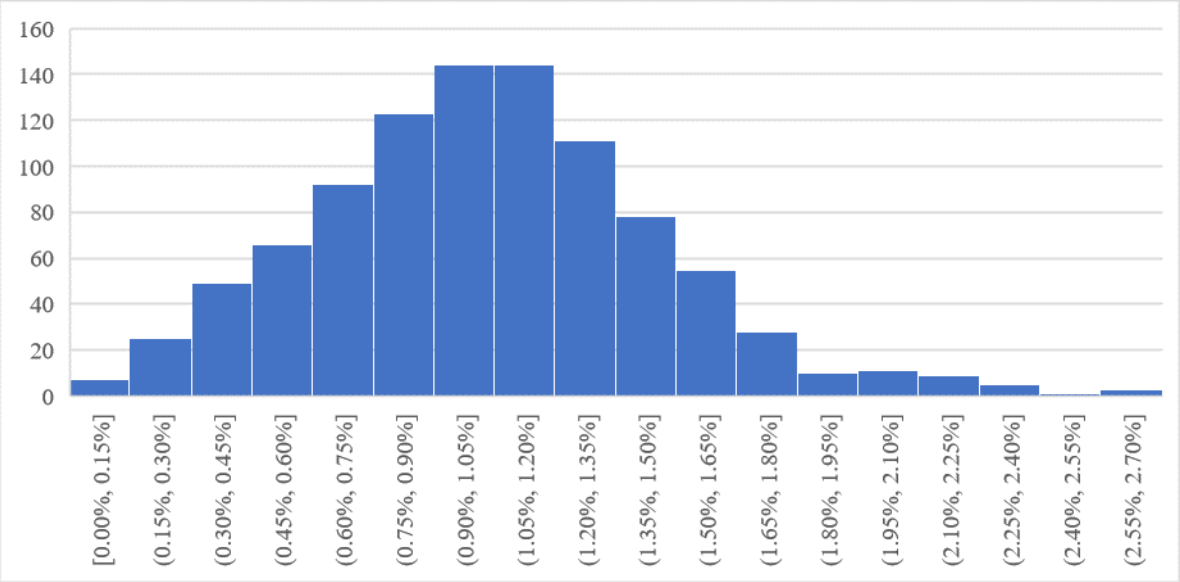

Figure 1. Share of village funds expenditure in total expenditure in 2021 year in rural municipalities. X-axis - % share, y-axis – number of municipalities.

The amount of funds to which the village fund will be entitled is determined by 31 July of the year preceding the year in which the funds are to be spent. The amount depends on the number of inhabitants of the solectwo's area, the realised current income of the municipality for the year preceding the financial year by two years and the number of inhabitants residing in the area of the municipality.

The next step is for the sołtys (village administrator) to convene a village meeting of all residents of the sołectwo by 30 September at the latest, at which they will decide on the allocation of funds. According to the law, a project proposal can be submitted for discussion by the sołtys, the village council (rada sołectwa) or at least 15 adult residents of the sołectwo.

In order for an application to the village fund to be implemented, it must meet three conditions. Firstly, the undertakings fall within the catalogue of the municipality's own tasks. Secondly, they are in line with the municipality's development strategy. Thirdly, they serve to improve the living conditions of the residents. There are also a number of formal requirements (e.g. cost estimates, project documentation) which affect the possibility of the application being accepted by the executive body of the municipality. The approved application is included in the draft municipal budget for the following year.

During the budget year, the village may submit a motion to the mayor to change the undertakings or their scope to be implemented under the fund. Tasks from the village fund are implemented in accordance with the description in the application.

The role of the sołtys and residents is not limited to the adoption and submission of the application. It involves, among other things, participation in the implementation of the project, which can be their work or a contribution in kind.

An important issue here is also the possibility of obtaining refinancing of part of the incurred expenses of the village fund from the state budget in the following year.

Thus, there are three key points here at which it was possible to change the decision on the composition and allocation of the village fund. Firstly, adoption of a resolution, secondly, selection of projects and thirdly, the preparatory phase of project implementation.

3.2. Data Analysis

Municipal expenditures within the village fund are of an optional nature. This means that in case of financial problems of municipalities (e.g. caused by the Covid-19 crisis), the decision to reduce these expenditures is one of the first that can be taken to ensure that the main tasks of the municipality can be carried out. The Ministry of Finance indicated that, after 2019, the number of municipalities in which village fund was enacted was decreasing. In 2018 it was 1,596 municipalities, in 2019 it was 1,593 municipalities, in 2020 it was 1,527 municipalities and in 2021 it was 1,498 municipalities. An analysis of the data for rural municipalities that did not continue with the village fund in 2020 or 2021 shows that in 2020 only 9% of municipalities that did not implement the village fund for next year experienced a decrease in their own income, while in 2021 it was about 46% of municipalities. Taking the 2020-2021 opt-outs from the village fund together, it is apparent that as many as 43% of municipalities experienced a decrease in own income.

Table 1 compares the changes in the percentage of rural municipalities between 2018 and 2021 in which the village fund was spent by region (voivodship). It can be seen that the level of implementation of village council funds varies between regions and changes over the period studied. One of the highest percentages of rural municipalities (80%) and at the same time the most stable situation was characterised by the Opolskie voivodship. Thus, the question arises whether in this voivodship, while maintaining the functioning of the village funds, the directions and scale of spending from the village fund changed during the Covid-19

Table 1. The percentage of rural municipalities between 2018 and 2021 in which the village fund was spent (by region)

Region/Voivodeship	2018	2019	2020	2021
Dolnośląskie	76%	74%	74%	65%
Kujawsko-pomorskie	73%	78%	76%	71%
Lubelskie	71%	69%	74%	68%
Lubuskie	79%	74%	85%	74%
Łódzkie	47%	46%	48%	42%
Małopolskie	64%	65%	64%	63%
Mazowieckie	61%	63%	57%	52%
Opolskie	80%	80%	80%	80%
Podkarpackie	86%	84%	83%	85%
Podlaskie	33%	42%	46%	40%
Pomorskie	69%	69%	73%	73%
Śląskie	64%	68%	70%	71%
Świętokrzyskie	55%	44%	48%	42%
Warmińsko-Mazurskie	64%	73%	66%	66%
Wielkopolskie	76%	78%	74%	71%
Zachodniopomorskie	58%	56%	50%	48%
Poland	65%	66%	66%	62%

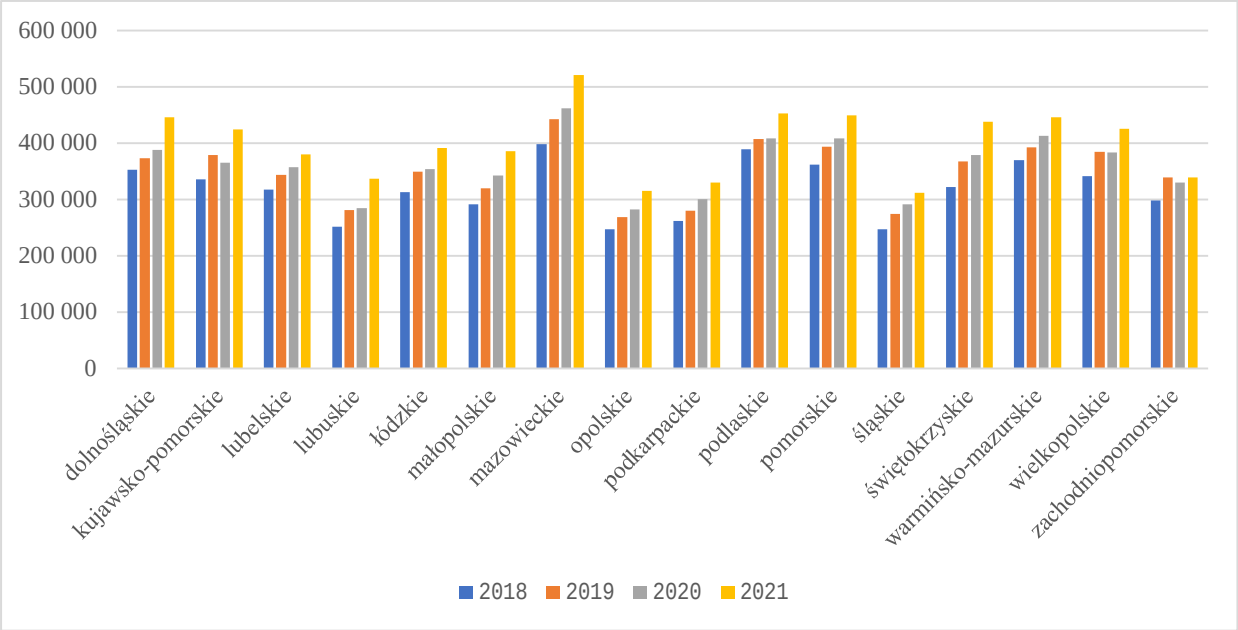

Figure 2. The expenditure of village funds per number of municipalities by regions (PLN)

pandemic. On the contrary, the highest percentage of rural municipalities using village funds was recorded in Podkarpackie (85%), and here it can also be indicated that the high level of utilisation of the sołecki fund was maintained. On the other hand, the lowest percentage throughout the study period was in Podlaskie (from 33% to 46%), and the greatest loss of municipalities was recorded in Lubuskie (11%).

A comparison of expenditures within the framework of village funds per number of municipalities indicates that, despite the mentioned resignation of some of them from the village fund, a relative increase in these expenditures can be noted in individual voivodships (Figure 2). The main directions of spending under village funds include expenditure on transport and communications, public safety, culture, sport and recreation. Figure 3 illustrates the changes in the structure of the main directions of spending from village funds (nationally).

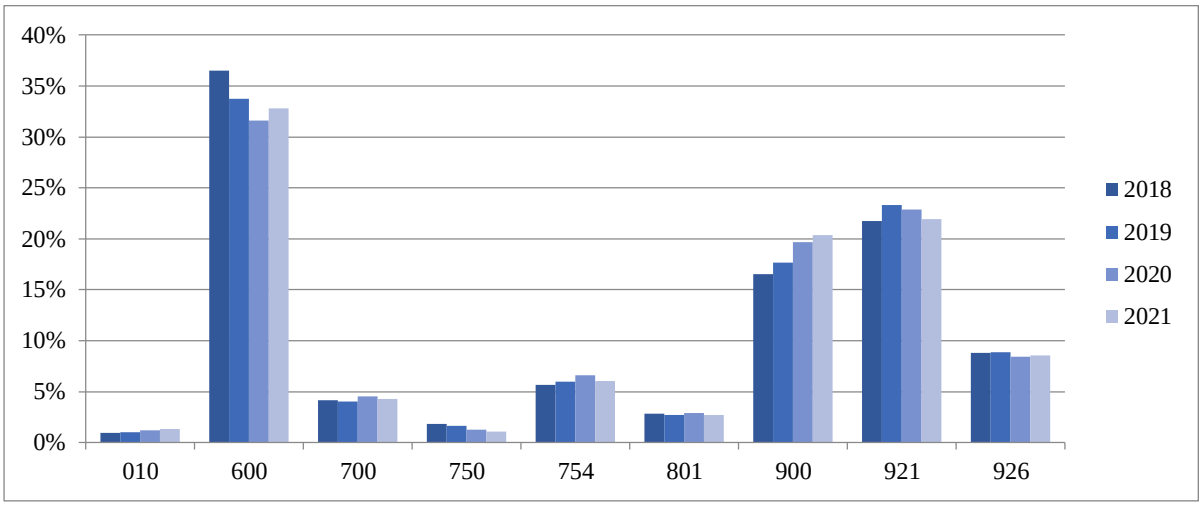

Figure 3. The structure of the main directions of spending from village funds (nationally)

A decrease in expenditure in the area of transport and communications (exp. 600) in particular in favour of expenditure in the area of municipal management and environmental protection (exp. 900) and expenditure related to public safety and fire protection (exp. 754) is evident. There are also expenses for agriculture and hunting (exp. 010), housing management (exp. 700), education and upbringing (exp. 801), public administration (exp. 750), physical culture (exp. 926). A detailed analysis of the direction of change in individual expenditure categories in municipalities measured against the 2019 expenditure level shows that in the first year of the pandemic there was a reduction in expenditure in more than half of the rural municipalities in all for the first category but in the rest of major categories it was between -5 and 5 percentage points (Figure 4). In contrast, the trend was reversed in 2021 compared to 2019.

The question therefore arises as to whether variations can be observed for individual regions. Figure 5 shows changes in the share of expenditure on transport and communications (exp. 600) from the village fund in individual voivodships in the period under study. A decrease in the share of this group of expenditures, analogous to that observed nationally, can be seen in most of the voivodships. It should be noted that it was the year 2020 that for more than half of the voivodships marked the lowest share of these expenditures.

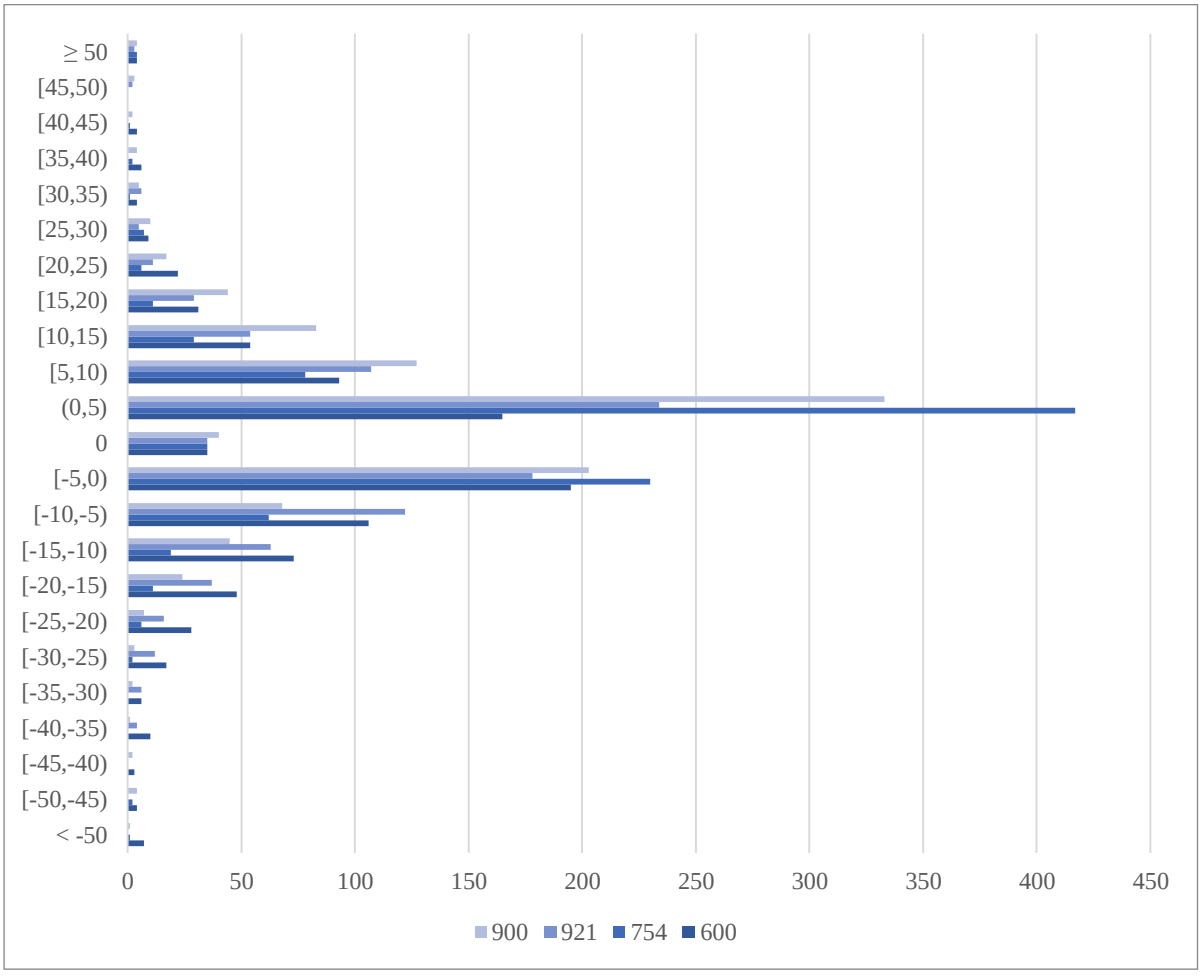

Figure 4. Changes in the level of municipal expenditure areas from the village fund in 2020 (four main areas of expenditure in percentage points). Vertical axis – number of municipalities, horizontal axis – change in 2020 compared to 2019 in percentage points.

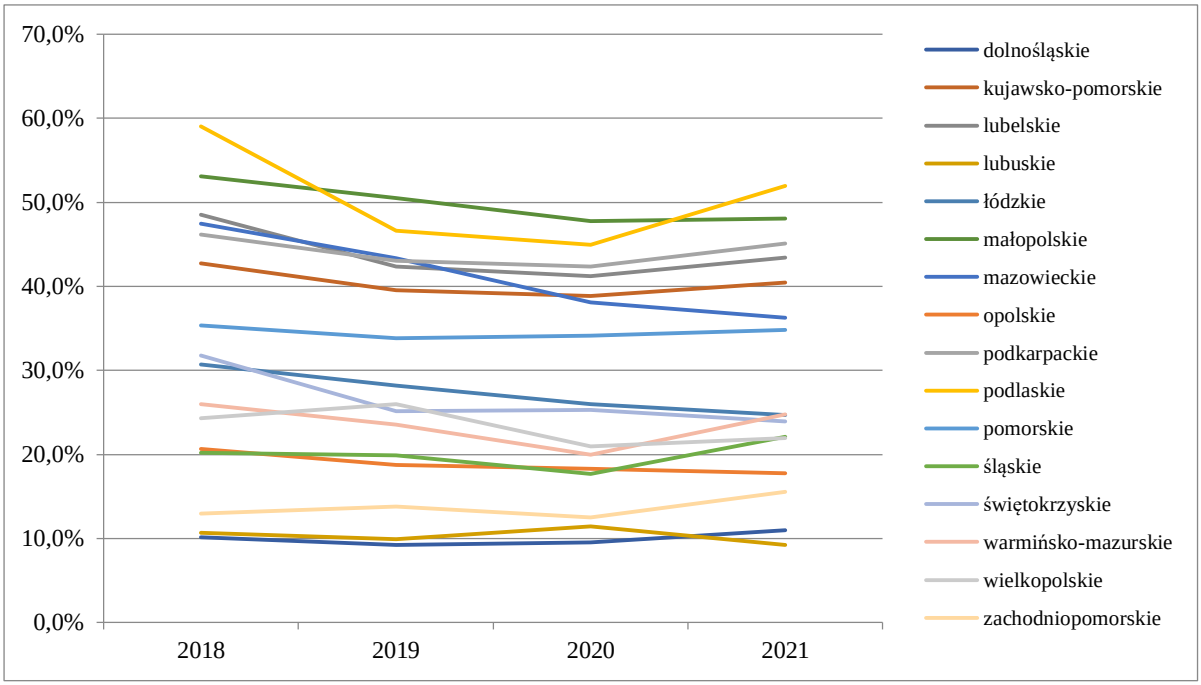

Figure 5. Changes in the share of expenditure on transport and communications (exp. 600) by regions

Figure 6 shows changes in the share of expenditure on municipal management and environmental protection (exp. 754). There was a large regional variation in the share of this group of expenditures, which in 2021 ranged between 13% and 36%. In as many as 13 voivodships, these expenditures increased by 2 to 5 percentage points during the pandemic period.

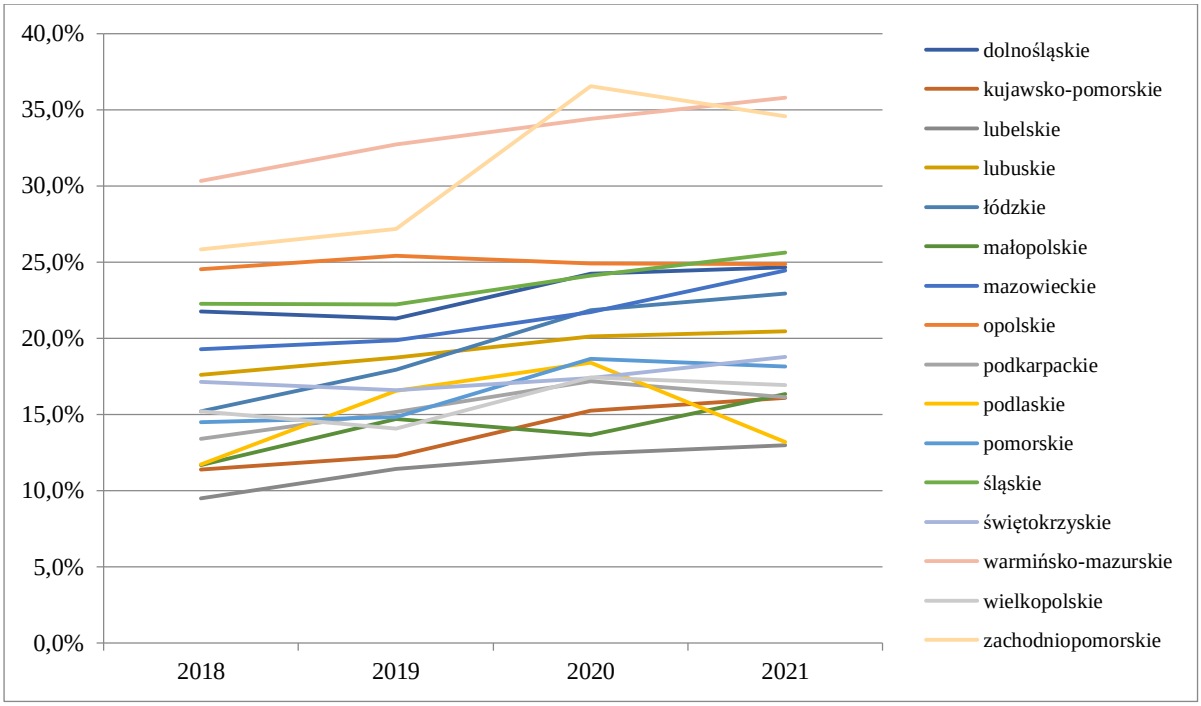

Figure 6. Changes in the share of expenditure on municipal management and environmental protection (exp. 754)

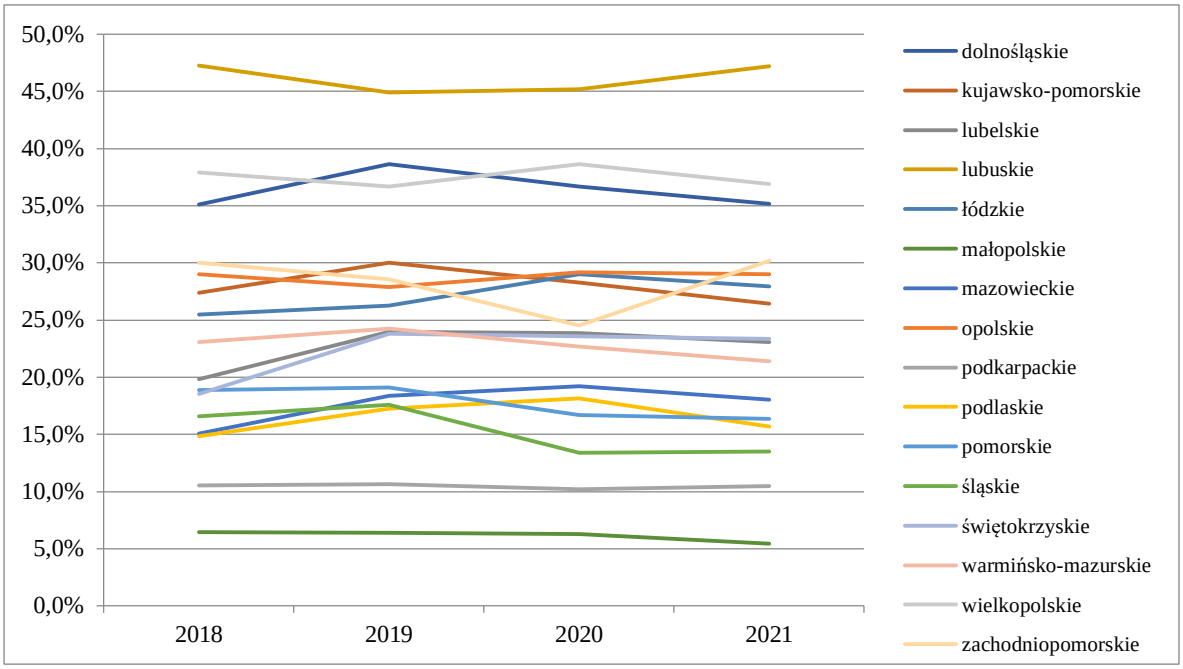

Figure 7. Changes in the share of this expenditure for culture and national heritage protection category (exp. 921) by region

Another important area of expenditure of rural municipalities under the village fund was culture and national heritage protection. Changes are shown in Figure 7.

As can be seen, in contrast to the previous categories, there were no significant fluctuations here (in proportion to the scale of the share of these expenditures in total expenditures). What can be seen, however, is a significant variation in the importance of this category of expenditure between regions. In order to analyse the stability of the structure of expenditures from the sołecki fund, expenditures were analysed in the Opolskie and Pokarpackie voivodships, which were characterised by a high and stable percentage of municipalities with a sołecki fund. Figure 8 illustrates the main directions of spending in 2018-2021 in the Opolskie. Figure 9 illustrates the main directions of expenditure in 2018-2021 in the Podkarpackie. Both in the Opolskie and Podkarpackie, despite differences in the structure of expenditure, there were no significant changes in the directions of expenditure during the pandemic (on a regional scale).

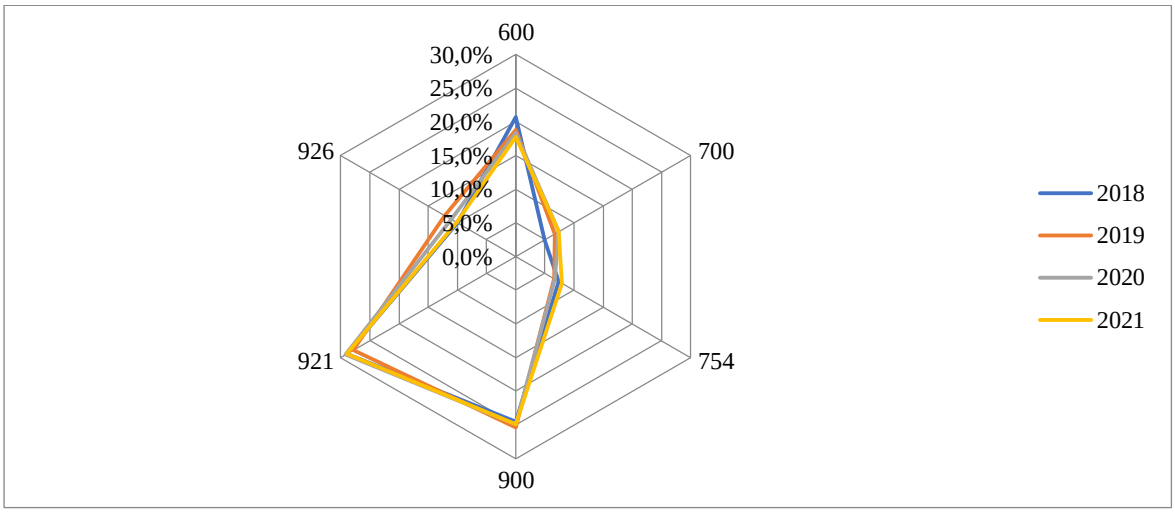

Figure 8. Village funds main expenditures share in Opolskie

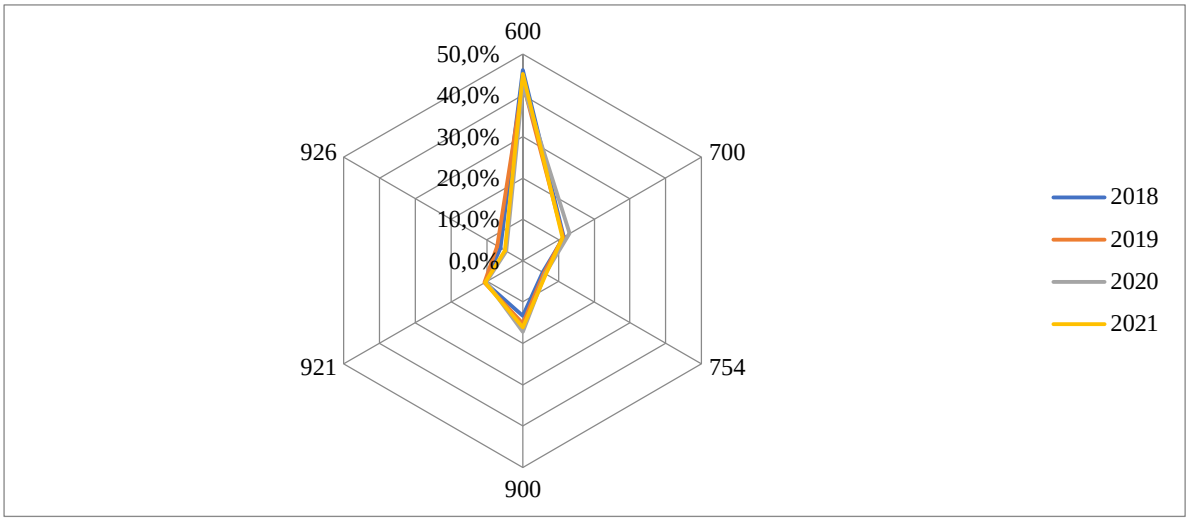

Figure 9. Village funds main expenditures share in Podkarpackie

4. Discussion and Conclusions

The analysis of the data carried out makes it possible to answer the research questions posed. The first research question RQ1 concerned changes in the number of municipalities that used village funds during the pandemic. The research showed a decrease in the number of rural municipalities using village funds during the pandemic on a national scale. At the same time, it should be noted that there was a significant regional variation here (Table 1). In regions where a high number of municipalities with a village fund was recorded before the pandemic, there was not a high degree of abandonment of the village fund during the pandemic period. In regions with a lower percentage of municipalities with village funds before the pandemic, on the other hand, the scale of the decline was greater. The assumption of a significant impact of the Covid-19 pandemic on changes in the use of village funds by municipalities seems questionable. Other possible factors could have been a decline in interest, exhaustion of ideas, a decline in civic activity, or a phase of the political budget cycle (the distant timing of the next election). To gain a better understanding of the rationale for the abandonment of village funds, it would be necessary to reach out to individual decision-makers in the municipalities with a corresponding questionnaire/direct interview.

The second research question RQ2 concerned the impact of the Covid-19 pandemic on the change in spending directions of village funds. This change could have been due to the need to redirect spending to other purposes than in previous years. The reason for this change could be that these expenditures are largely related to culture, education and sport and recreation, activities that were often curtailed during the pandemic. Secondly, there may have been an increase in (sanitary) security needs. The analysis showed that, nationally, there was little change in the direction of expenditure – there was an increase in expenditure on municipal management and environmental protection (900) and a slight increase in expenditure on public safety and fire protection (754). On the other hand, expenditure on transport and communications (investment) decreased, especially in 2020. However, analysis in the case of the previously mentioned Opolskie and Podlaskie voivodships indicates that no significant changes occurred in the case of villages from these voivodeships.

The Effectiveness of Village Fund Utilization in The Covid-19 Pandemic Era was solved also by Prastica and Suswanta (2022). The results show that, through the eight indicators that were tested to determine whether the village fund utilization in Batu Lambang village was effective, all of them were effective. This can be seen by the fact that the village funds were used to reach the predetermined goals, such as Cash Transfers, and the procurement of COVID-19 mitigation and prevention tools. In addition, all of those were done in a timely, economically effective manner, as prescribed in the fund's planning.

In conclusion, it should be emphasised that the above analysis is preliminary and constitutes only a probe to identify the research problem. In the subsequent stages of the research, in addition to a more in-depth analysis of quantitative data (at the level of individual municipalities), it would be advisable to undertake a qualitative study to identify the reasons why individual municipalities decided not to continue with the village fund.

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Conflict of interest: none.

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The Brand Identity of a Local Company in the Liberec Region

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Abstract: Building a strong corporate identity and brand is currently an opportunity for companies to reach out to new customers and increase brand trust and brand value across markets. Therefore, for a company to become well-known and successful, it needs to constantly build its brand to make it stand out from competing products and strengthen its position in the eyes of the customer. This scientific paper thus focuses on describing and analyzing the brand identity of a syrup producer in the Liberec region. The result part analyzes the corporate identity of the Kitl company and its key factors. This part further focuses on analyzing brand identity through exploratory factor analysis (EFA) and presents the results of the EFA. The results also explain the key elements of brand identity and explore the impact of socio-demographic variances on brand identity factors. The scientific paper's discussion focuses on deriving recommendations that could help Kitl build a strong brand identity and increase the overall brand value of the company. The final part of this paper discusses the limitation of marketing research and research results.

Keywords: brand identity; local brand; brand value; exploratory factor analysis

JEL Classification: M31

1. Introduction

Building a company's identity is one of the most important aspects of marketing for any company that wants to succeed in today's competitive world. Unfortunately, however, many companies do little to address the issue of identity or do not build it as a complete marketing ecosystem. Their identity is then very fragmented on the outside and the public tends to have a negative perception of it (Kornum, 2017). Yet identity plays a fundamental role in brand perception (Aaker, 2003). Customers choose brands whose identity matches the vision and mission of the company and the identity of the customers themselves (Přibová et al., 2000). A well-constructed identity has an impact on the loyalty of customers, who can identify with the brand and build a positive rapport with it. This loyalty is then manifested in repeated purchases of the brand and positive "Word of Mouth" (Lin & Sung, 2014). Companies must take care to build their brand identity so that it is convincing for customers.

This paper focuses on a company called Kitl. Kitl s.r.o. (Ltd.) was established in 2005 in Jablonec nad Nisou with the idea of producing medicinal wines. After its initial success, it began to expand its portfolio. Originally a producer of alcoholic beverages with herbal mixtures, the company soon came to offer an extensive range of non-alcoholic beverages as well. Its first fruit syrup was launched on the market in 2012. Kitl now offers twelve different

flavors of syrup. The company builds its identity through a well-thought-out marketing strategy, which includes the use of a whole range of marketing communication channels. The main idea of the strategy as a whole is to present the brand as that of a local company using high quality ingredients to make delicious products. On the other hand, the company strives to implement an intensive distribution strategy. The brand is available in a number of supermarkets (such as Billa), in large e-shops (e.g. Dr.Max), in local health food stores, and on markets. In addition to these distribution channels, customers can buy lemonade made from Kitl syrup at McDonald's. The company's distribution strategy, therefore, does not reflect the communicated brand identity based on localness, quality, and a premium brand.

The research team was interested in determining the main factors of this brand's identity and the attitude towards it as shown by member of generation Z, represented by university students in a situation where they can buy syrups practically anywhere. The members of generation Z were born between 1996 and 2010. Many studies have shown that this generation has a different attitude towards brands, and therefore has a different perception of brand identity. At the same time, this is the emerging generation, which will be the segment with the greatest purchasing power in a few years. It is therefore important to focus on this generation and determine what attitudes it has towards brands and how companies should adjust their marketing mix to fully reflect the special requirements of this generation (Spitznagel, 2020).

The main objective of the research was to evaluate Kitl's ability to build a local brand identity in a situation where an intensive distribution strategy is used.

1. Research question: What are the main factors of Kitl's brand identity?
2. Research question: What are students' attitudes towards the individual attributes of Kitl's brand identity?
3. Research question: What are the main socio-economic characteristics that influence students' attitudes towards the main factors of Kitl's brand identity?

2. Theoretical Part

According to AMA (2022), brand can be defined as a: "*name, term, design, symbol or any other feature that identifies one seller's goods or service as distinct from those of other sellers.*". A brand can also be described as a set of tangible and intangible attributes designed to create awareness and identity, and to build the reputation of a product, service, person, place, or organization (Sammut-Bonnici, 2015). Branding strategies are built on the interdependent frameworks of competitive brand positioning, value chain development, and brand equity management (Karlíček, 2018; Sammut-Bonnici, 2015; Keller, 2007). According to Aaker (2003, p. 60), brand equity can be defined as: *"A set of assets and liabilities linked to a brand, its name and symbol, that adds to or subtracts from the value provided by a product or service to a firm and/or to that firm's customers."*. According to Keller (2007), brand equity is the effect that brand knowledge has on consumer response to the marketing of a brand, with the effect occurring when the brand is known and when the consumer possesses favorable, strong, and unique brand associations. Many tools and concepts can be used as a tool for creating favorable, unique, and strong

associations (e.g. brand knowledge, brand image, brand recognition). The following paragraph describes one of these tools: the concept of brand identity.

The Economic Times (2022) defines brand as the name of a company, product or service that is created with the aim of building an identity. According to Aaker (2003, p. 60), identity is: *"a unique set of associations that strategists of the world of commercial brands strive to create and maintain. These associations represent what the brand represents and at the same time indicate a certain promise to customers by the manufacturer."* The concept of identity is thus shaped in a company through vision, corporate culture, the personality of its leaders; brand positioning; marketing communication and other factors that the company sets and adheres to in the long term (Mindrut et al., 2015). The work of de Chernatony (2002) states that, in addition to the above, the concept of identity also includes moral image, goals and values, which together form the individuality of a business. Another important factor that affects the strength of the brand and the strength of the identity itself is the emotions that customers feel towards the brand (Janonis et al., 2007). As is evident from the above, the management of a corporate identity depends on many different factors, which, when used correctly, help to build a positive image of the company – i.e., what the company wants the brand to represent in the customer's mind. Mindrut et al. (2015) say that: *"If a potential customer can relate to previous experience with the identity of a brand, he surely developed a brand image and is more likely to prefer that specific brand".* Identity is thus an integral component of the overall value of the brand, which helps to set the overall direction, meaning and purpose of the brand in the selected market (Aaker, 2003). Last but not least, use of the concept of identity also helps companies define a competitive advantage and make their brand stand out from competitors.

3. Methodology

This scientific paper was created in cooperation with a marketing employee at Kitl. The main objective of the collaboration was to determine students' attitudes and preferences toward brands of syrups. Only the part focusing on brand identity related to the Kitl brand was chosen for this work. The Computer Assisted Web Interviewing (CAWI) method was used to collect the data, and an online questionnaire was created (more about the questionnaire design and respondents can be found in the following subchapters).

3.1. Questionnaire Design

An online questionnaire was created to collect the data. Before the real data collection started, a pilot version of the questionnaire was provided to a small group of students. After the pilot version was tested, all the necessary comments and needs were included in the final version. The final version of the questionnaire was created in Google Forms. It consisted of the of 27 questions (6 related to the socio-economic characteristics and 21 related to the Kitl brand). A Likert scale was used to determine the attributes of the brand identity. The questionnaire contained a set of socio-economic questions, which we asked with a set of closed, single-answer questions. To determine the respondents' attitudes towards syrups, a closed question with four possible answers was created: positive attitude – I buy syrups, positive attitude – I don't buy syrups, negative attitude – I buy syrups, negative attitude –

I don't buy syrups. The attitude towards syrups and the socio-economic questions were used as independent variables in an analysis of variance. The data were collected between March 2021 and May 2021. The questioner focused on five main fields of researched area:

1. Attitudes in the field of syrups and beverages,
2. Kitl brand knowledge and experience,
3. Preferences and perceptions of Kitl brand,
4. A lifestyle of respondents,
5. Respondent demographic classification.

3.2. Respondents

The respondents of this questionnaire were Czech students from the Faculty of Economics of the Technical University of Liberec. The students were chosen from all student programs and all forms of these programs. This group of respondents was selected on demand by the CEO of Kitl. According to Hair (2015), the student respondents should meet the following criteria:

- the respondents should possess the information the research project is designed to collect,
- the respondents are accessible,
- the respondents have knowledge of the topic of interest,
- the respondents are available during the time frame.

All the students from the group of respondents met the above criteria, thus:

- The students represent an interesting potential segment of customers for developing new Kitl products.
- The students' consumption behaviors and perceptions resemble those of typical users; this has been confirmed by different industry sources (Grimm, 2005; Hayes et al., 2006; O'Cass & Grace, 2004).
- The student segment is homogeneous. That means that this homogeneous segment can reduce non-controllable confounding variables (Matzler et al., 2006).
- Students know about and are familiar with branding issues. Many branding researchers consider the use of student respondents to be preferable to the use of other groups (Yoo et al., 2000).

According to several authors (e.g., Aaker & Keller, 1990; Martinez & de Chernatony, 2004), these are only a few reasons why brand marketing researchers use students as their questionnaire respondents.

The data collection was based on a simple random sampling method. The total number of Czech students at the Faculty of Economics of the Technical University in Liberec was 923. The author chose every second student from this group of 923 students. From the 462 respondents, the author received 303 responses. The response rate was 65.5%. In the group, 57% of the respondents were women; the remaining 43% were men. The respondents were from different age groups (age range 20-40). Most of the students (54.46%) were from the 20-22 age group. Detailed information about the group of respondents can be found in Table 1.

Table 1. Respondents

Demographic criteria	Variables	Counts	
Sex	Men	173	57.1%
	Female	130	42.9%
Age	<20-22>	165	54.5%
	<23-25>	127	41.9%
	<26-28>	6	1.9%
	<29-40>	5	1.7%
Income	X < 5,000 CZK	83	27.4%
	<5,000-10,000 CZK>	118	38.9%
	(10,000-15,000 CZK>	54	17.8%
	(15,000-20,000 CZK>	21	6.9%
	(20,000-25,000 CZK>	7	2.3%
	X > 5,000 CZK	20	6.7%
Population of town/village	X < 1,000	52	17.5%
	(1,000-5,000>	76	25.0%
	(5,000-10,000>	32	10.5%
	(10,000-50,000>	53	17.4%
	(50,000-100,000>	23	7.6%
	X > 100,000	67	22.0%
Living situation	with parents	137	45.2%
	student dormitory	100	33.1%
	shared flat (with friends, other students…)	31	10.3%
	own flat	32	10.5%
	boyfriend's/girlfriend's house	1	0.3%
	rented flat	1	0.3%
	own house	1	0.3%

3.3. Statistics Used

Besides descriptive statistics, specifically location characteristics – mean, median and mode – were subjected to an Exploratory Factor Analysis (EFA), with the aim of creating factors from a data matrix containing a set of scale questions related to the Kitl brand identity. EFA is based on the assumption that dependencies between monitored variables are the result of the action of a certain smaller number of background unmeasurable variables, which are referred to as common factors. Bartlett's test of sphericity (P-value <0.05) and the Kaiser-Meyer-Olkin (KMO) measure must be fulfilled in order for the factor analysis to be performed. Certain bands are established for this condition that show how appropriate the use of factor analysis is. KMO ≥ 0.9 excellent, KMO ≥ 0.8 good, KMO ≥ 0.7 average, KMO ≥ 0.6 less suitable and KMO ≥ 0.5 borderline use. A varimax rotation was performed in this research to enable better interpretation of the results. The number of factors was chosen according to the Kaiser Rule, where the eigenvalue of the correlation matrix must be greater than one. The interpretation of the factors was based on the factor loads, which represent the

correlation coefficient between the variable and the factor. Loads of ≥ 0.5 were considered significant (Meloun & Militký, 2006).

In order to determine the influence, the socio-economic characteristics of the respondents had on their attitude towards the identified brand identity factors, a two-sample unpaired t-test was performed for variables with two values and a one-factor analysis of variance for variables with more than two values. The condition for the use of the two methods is that we have independent samples from normal distributions that are described by means and variances. In the case of large samples, it is not necessary to determine whether the data are normally distributed. In our case, we did not check the normality of the data. As part of these analyses, the hypothesis H0, that the mean values are the same, is tested against the hypothesis H1, that the mean values differ from one another (Budíková et al., 2010). All the claims were tested at the 95% significance level. In the event that H0 was rejected, and thus H1 was accepted, the analysis of variance further determined which pairs of mean values differed at the given level of significance. Fisher's LSD post-hoc test was used to determine significant differences (Šimonová, 2006).

4. Results

An exploratory factor analysis was performed to fulfill the first research question. In the first phase, 10 variables were entered into the factor analysis, formulated in the questionnaire based on previous communication with the company owner. These are the attributes of the brand identity that the company has formulated for the needs of its marketing strategy. The aim of the factor analysis was to summarize the information contained in a larger number of variables and reduce them to a smaller number of factors. A varimax rotation was performed in this research to enable a better interpretation of the results.

Table 2. Results of exploratory factor analysis

KMO	0.733
Bartlett's test	0.000
Number of variables in the FA	10
Number of factors	3

Table 2 presents the results of the Kaiser-Meyer-Olkin test, which came out at 0.733. This result shows that the use of factor analysis was chosen appropriately. Bartlett's test was also successful (P-value = 0.000).

Table 3. Results of principal component analysis

Component	Total	% of variance	Cumulative % of variance
1	2.996	29.959	29.959
2	1.644	16.445	46.404
3	1.291	12.915	59.319

Table 3 summarizes information on the total explained variability and the eigenvalues of the correlation matrix. The number of factors was chosen as 3 according to the Kaiser Rule. These three factors together explain 59% of the total variability.

Table 4. Factor analysis, varimax matrix

	Factors		
	Quality and Health	Local Brand	Taste
The syrups are made from quality ingredients.	0.622	0.281	0.338
The syrups are healthy.	0.739	0.104	0.097
The syrups are harmless to health.	0.640	0.069	0.062
The syrups are suitable for daily consumption.	0.727	0.044	0.274
They are made according to a traditional recipe.	0.675	0.050	0.368
I classify the syrups as premium products.	0.076	0.749	0.298
It is a local manufacturer.	0.000	0.823	0.141
I buy the syrups as the basis for homemade lemonade.	0.194	0.710	0.191
I like the taste of the syrups.	0.100	0.352	0.721
I buy the syrups at McDonald's.	0.094	-0.159	0.741

Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser normalization.

Table 4 presents the results of the factor analysis, namely the set of variables and the resulting three factors into which the variables clustered. We named the first factor Quality and Health. The factor contains claims that indicate that the product is high quality and also beneficial to the human body. In the second factor, named Local Brand, there are claims indicating that the product is local and of premium quality, as well as the fact that homemade lemonade can be made from the syrups. There is therefore an emphasis on tradition associated with the local brand and also the tradition of drinking homemade lemonades, which the company has helped to restore in the Czech Republic through its marketing communication. The last factor is Taste. This factor reflects the fact that customers like the brand due to its excellent taste, so much so that they even prefer it over the traditional sweet drinks at McDonald's.

The answer to the second research question was obtained using descriptive statistics. Table 5 shows the location characteristics of the individual variables. The students agreed the most with the fact that they like the taste of Kitl syrups while, on the other hand, they did not particularly agree with the claim that they would drink Kitl lemonade at McDonald's. Both claims come under the Taste factor. The claim with the second highest level of agreement was about the quality of the ingredients used. This variable belongs to the Quality and Health factor, all of whose variables are given a positive or average rating. The third highest level of agreement was with the claim that Kitl syrups are premium products. This variable belongs to the factor Local Brand, the other variables of which were not rated very positively.

Table 5. Descriptive statistic of individual variables

	1	2	3	4	5	6	7	8	9	10
Mean	1.72	1.85	2.01	2.12	2.50	2.62	3.34	3.48	3.62	4.27
Median	2	2	2	2	3	3	3	4	4	5
Mode	2	2	1	2	3	2	4	5	5	5

Note: 1 I like the taste; 2 They are made from quality ingredients; 3 They are premium products; 4 They are made according to traditional recipes; 5 They are harmless to health; 6 They are healthy; 7 They are suitable for daily consumption; 8 I buy them to make homemade lemonade; 9 It is a local manufacturer; 10 I buy them at McDonald's.

The individual factors identified from the factor analysis were further entered as dependent variables in the analysis of variance, or the two-sample unpaired t-test (research

question 3). The aim was to determine whether the socio-economic characteristics of the respondents and their relationship to the syrups influence their attitude towards the individual brand identity factors. Table 6 shows the statistically significant results. We can see that only the effect of gender and attitude towards the syrups was demonstrated on two of the three factors. No statistically significant influence was demonstrated for the characteristics of age, size of place of residence, type of household or the income of the respondents. Women and those who have a positive attitude towards the syrups and buy them have a more positive attitude towards the Quality and Health factor. Men and those who have a negative attitude towards the syrups and do not buy them, do not believe so much in the health benefits of Kitl syrups. Respondents with a generally negative attitude towards the syrups have a more negative attitude towards the Local Brand factor, which causes them to not buy the syrups.

Table 6. ANOVA and t-test to determine the relationship between variables

Factor	characteristic	F-Ratio/t statistic	P-value
Quality and Health	gender	2.214	0.028
	attitude towards syrups	10.08	0.000
Local Brand	attitude towards syrups	4.667	0.003

5. Discussion

Kitl is specific in its effort to build a brand identity that is built on tradition, localness and high quality. On the other hand, it is not opposed to an intensive distribution strategy, which currently also includes a range of homemade lemonades available at McDonald's. The company owner believes in this cooperation and claims that it has resulted in improvements to the company's production process and therefore, better quality products. In addition, he sees the link with McDonald's as a logical step because, as he says, the two companies profile themselves as offering high quality products. In his opinion, Kitl and McDonald's also share the same segment of customers, mainly young people, for whom food quality is a priority (Pšeničková, 2019).

The main objective of this paper was to evaluate Kitl's ability to build an identity as a local brand while using an intensive distribution strategy, including cooperation with McDonald's. The research found that the main factors of the brand identity are the Taste of the syrups, Quality and Health, and Local Brand. These are the dominant attributes of the identity that the company should communicate. The excellent taste of the syrups and high quality are also attributes communicated by McDonald's. The situation is different in the case of the product with health benefits attribute and the local brand attribute. Research conducted by Nielsen showed that the Czechs see the unhealthy nature of the food at McDonald's as its biggest downside, despite the fact that the company tries to communicate the high quality and freshness of the ingredients it uses (Nielsen, 2020). This finding goes against the identity that the Kitl brand is building. The link with McDonald's could result in Kitl lemonades being perceived as unhealthy. However, the research has shown that the respondents do not associate Kitl with McDonald's very much yet. Most of them do not buy Kitl lemonade at McDonald's but tend to buy the syrups for home use. The last factor of the Kitl brand identity, i.e., local

brand, is also problematic in contrast to the global McDonald's brand. The results of the research show that the respondents do not particularly associate the Kitl brand as being the brand of a local manufacturer. This could be a problem for the company in the future. Kitl should use its marketing communication to clearly explain its connection with McDonald's to its customers, so that they do not see it as a national or even international brand. On the other hand, the students report that they like the taste of Kitl syrups, believe they are made from quality ingredients, and see Kitl as a premium brand. These are identity factors that are perceived by customers in accordance with the set brand identity and were therefore not influenced by the established distribution strategy. It is evident that students trust the brand and their trust is not influenced by where they specifically buy the product. This finding contradicts the commonly accepted premise that the entire marketing mix of a brand should be consistent and that the individual tools should complement one another (Karlíček, 2018). With this particular example, we can see that if a company builds its distribution network gradually, future expansion into retail chains and possibly fast-food outlets will not necessarily be a problem. Kitl began to sell its products on markets and in specialized shops offering local produce, and this helped it to build a reputation as a quality brand. It is evident that this is how customers perceive it now, too, when it is already a stable company on the market, whose products are available practically everywhere.

However, it may be said that not all customers see the attributes of brand identity in the same way. We found that women see the brand as being of higher quality and believe more that the products are beneficial to health. People who have a generally positive attitude towards syrups and buy them on a regular basis have a similar view of the brand. The company should therefore work on the segment of men and also those who have a more negative attitude towards syrups, to convince them that they can buy Kitl products without having to feel guilty that they are consuming an unhealthy or low-quality product.

6. Conclusions

This scientific paper focuses on the brand identity of a selected syrup manufacturer. The main objective of this paper is to evaluate Kitl’s ability to build a local brand identity while using an intensive distribution strategy. The main factors of the Kitl brand identity were presented based on marketing research and the results obtained from the exploratory factor analysis. These main factors were subsequently described individually with regard to how they are associated with the overall value of the manufacturer's brand. Although we did find answers to all the research questions, it is important to mention that this research does have certain limits. One limitation of the research is the assumption that students from the Faculty of Economics of the Technical University in Liberec were more familiar with the brand than students at other universities in the Czech Republic. This may be due not only to the fact that the university and the manufacturer are based in the same region, but also to the fact that the university and the syrup manufacturer have an established partnership relationship. A more positive relationship to the identity of the selected brand can be created through better knowledge of the brand across the respondents and the factors mentioned above. In order to

generalize the results and conclusions resulting from the research, it would be necessary to carry out research across other universities in the Czech Republic.

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Conflict of interest: none.

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The Impact of the COVID-19 Pandemic on Czech Gaming Brands

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Abstract: The COVID-19 pandemic has led to an unprecedented situation with an enormous impact, particularly in the health sector, but also a significant negative impact on the global economy. At the start of the COVID-19 pandemic, most financial markets collapsed but not all industries suffered equally. The gaming industry was one of the least affected areas. The COVID-19 pandemic affected lives in many ways, including how people chose to spend their leisure time and how they coped with the unprecedented circumstances. In the first half of 2020, several billion people were forced to stay cooped up in their homes, under stress, anxiety, and in boredom, and it is these realities that have taken a toll on gaming companies. The Czech gaming industry has been thriving recently, but the impact of the COVID-19 pandemic on Czech companies has not yet been quantified. The goal of the research is to examine in more detail the impact of the first wave of the COVID-19 pandemic on Czech companies operating in the gaming industry, both from the financial and user perspective. The research is based on an analysis of the revenue of brands in the Czech gaming industry and the trend in the number of users. The paper concludes with a summary of the results obtained and a discussion of the possible causes.

Keywords: COVID-19; Czech game industry; gaming brands; social networks

JEL Classification: M15; F65; M31

1. Introduction

The first wave of the COVID-19 pandemic forced governments around the world to restrict population mobility and enforce social distance to limit or completely stop the spread of a new and previously unknown virus (Anderson et al., 2020; Wilder-Smith et al., 2020). As of March 2020, more than one billion people have been trapped in their homes for several weeks. Very strict quarantine measures were imposed in many countries, travel was restricted, social and cultural events were canceled, and public services were closed. The health, economic, and social consequences of the COVID-19 pandemic were enormous. While it was not the first time a viral disease had affected a human population, the COVID-19 pandemic had an unprecedented global reach. The situation regarding the COVID-19 pandemic also deteriorated significantly again in late 2021, when the more contagious omicron variant began to spread. By early 2022, continental Europe in particular was facing another wave of COVID-19. By March, most countries were seeing record numbers of infections, but fewer people were admitted to hospitals and there were fewer casualties. This

is also why most countries have started to phase out strict measures and are returning to their pre-pandemic way of life (López-Cabarcos et al., 2020).

Due to very strict anti-epidemic measures and frequent closures, people were looking for ways to spend time in isolation. Preventive measures against the spread of the coronavirus raised the bar for movie and music consumption. Many people turned to the virtual world of video games. People suddenly had more free time, irregular daily routines, and children were learning online. Due to these factors, the gaming industry experienced record success. Thus, it can be said that the already very successful gaming industry had its best years in a decade thanks to the COVID-19 pandemic.

In the Czech Republic, the gaming industry was one of the few industries that were not affected by the coronavirus pandemic. Czech gaming brands have been thriving for a long time. Annual turnover is around five to six billion crowns (EU2022.CZ, 2022). In 2020, gaming companies were relatively prosperous and the whole sector was growing. The turnover increased by 17% compared to 2019 and the total number of people working in game development companies reached over 2,000 (Langerová, 2021). In 2021, turnover even increased by 33% (GDA, 2021). The growth of turnover in the game industry is expected to continue in 2022. According to GDA (2021), the turnover of Czech game companies is expected to increase by 6% in 2022 (Jarůšek, 2022). There are more than 135 gaming companies operating in the Czech Republic.

The aim of the presented research is to examine in more detail the impact of the first wave of the COVID-19 pandemic on Czech companies operating in the gaming industry, both from the financial and user perspective. The first wave of the COVID-19 pandemic is defined by the period from March to May 2020, when some of the most stringent restrictions were introduced in the Czech Republic. The research is based on the analysis of secondary data of a financial nature on individual gaming brands operating in the Czech gaming industry. Furthermore, the research is based on primary data collection conducted from November to December 2022. The aim of the primary research was to test the assumption of increased interest in video games during the first wave of the COVID-19 pandemic among Czech students. Primary data was collected through a questionnaire survey conducted among 394 students of the Faculty of Economics, Technical University of Liberec (hereinafter TUL). As a result, 151 responses were collected using the Survio service.

2. Theoretical Background

The new type of coronavirus was first identified in December 2019 in Wuhan, China. On 11 March 2020, the World Health Organization declared a global pandemic of the so-called COVID-19 disease. At the same time, countries around the world began to implement various measures to stop the spread of this new disease. The measures taken have had a significant impact on all social developments. Educational institutions, restaurants, and cultural and entertainment venues (cinemas, theatres, sports stadiums, etc.) were closed. To prevent the spread of the coronavirus, the wearing of surgical masks, physical distance, mass testing, contact monitoring, quarantine, and isolation were introduced. Governments in many countries have introduced the concept of “social distancing” in society. Social distancing has

greatly restricted the free movement of people and on the other hand, has forced people to stay largely at home. Large numbers of people were ordered to quarantine or isolate themselves.

Government action and media pressure have caused many people to feel stressed, anxious, and depressed. People who were forced to stay at home for various reasons had to find other activities to escape the enormous stress load. These psychological factors have been reflected in the increased use of information and communication technologies. Due to all the governmental measures and restrictions, video games have become a good option to cope with isolation (Ko & Yen, 2020). According to Shanley (2020), the US telecommunication service provider Verizon has seen a 75% increase in online gaming activities. Stephen (2020) also adds that Steam reported more than 20 million users, the highest number of active users in its history. According to SuperData, the global games market was worth $139.9 billion in 2020, with the games industry growing by 12% year-on-year (VentureBeat, 2022). According to a report by US research company NPD Group (2022), the number of gamers in the US increased significantly in 2020. According to the research, four out of every five US consumers have played a video game since the start of the COVID-19 pandemic. The NPD Group (2022) adds that time spent playing video games increased during the COVID-19 pandemic. The research found that 35% of gamers increased their time spent playing compared to the previous period. Research by Barr and Copeland-Stewart (2022) confirmed that 71.3% of respondents spent much more time playing video games during the COVID-19 pandemic. Furthermore, the research found that 63.1% of respondents changed the types of games they played. Barr and Copeland-Stewart (2022) add that about 10.5% of respondents played video games several times a day before the COVID-19 pandemic, while more than 40% of respondents played video games several times a day during the COVID-19 pandemic.

Şener and Yalçın (2021) found that there was a significant increase in the number of active players during the COVID-19 pandemic. They further found through research that large companies in the gaming industry increased the value of their holdings and subsequently confirmed this hypothesis through statistical testing. They further concluded that during the pandemic period, the demand for video games increased and the share prices of gaming companies rose.

3. Methodology

The aim of the presented research is to examine the impact of the first wave of the COVID-19 pandemic on Czech gaming companies from an economic and user perspective. The research process can be divided into the following four steps.

Step 1: Create a list of companies to be evaluated and collect financial statements. The research focused on the period 2018-2020 due to the availability of financial statements. Corporate data for 2021 is not yet available for a significant proportion of businesses. The most well-known Czech gaming companies were included in the research. These companies are: Bohemia Interactive Studio, SCS Software, Warhorse Studios, 2K Czech, Amanita Design, Madfinger Games, Geewa, Grip Digital, Beat Games, Cenega Czech, Cinemax, DynamicDust, Gammosaur, McMagic Productions a Wargaming Prague (Ministry of Finance, 2022).

For the gaming companies mentioned above, it was necessary to obtain the necessary data from the financial statements, in particular the balance sheet and the income statement for the years 2018-2020. The obstacle to this step is that not all companies comply with the obligation to disclose selected data in the collection of documents. The commercial database MagnusWeb (Bisnode, 2022) was used as the main source of accounting data. If this database did not contain the required financial statements, the public (or commercial) register and the collection of deeds in the commercial register were used as a second source. The collection of documents contained the missing financial statements.

Step 2: Calculation of financial performance indicators. For the above-mentioned gaming companies, the selected ratios were then calculated. These ratios should give a basic overview of the financial situation of gaming firms. The first ratio selected was the return on equity ROE (see relationship 1). ROE is one of the basic ratios that provides an overview of the overall return on equity. The second ratio was ROA (see relationship 2). This ratio measures how profitable a firm is in relation to its total assets. A high ROA means that management is effectively using the company's assets to generate profits. The third indicator was ROS. The ROS (see relationship 3) expresses how much profit is left for the company from the sales earned. Earning after tax (further EAT) was used to calculate the above ratios.

$$ROE = EAT/Equity \tag{1}$$

$$ROA = EAT/Assets \tag{2}$$

$$ROS = EAT/Sales \tag{3}$$

Step 3: Comparison of financial characteristics in individual years. In this step, the differences between the median values of the above-mentioned characteristics in the years 2018-2020 were compared using the non-parametric Mann-Whitney-Wilcoxon W test. The Mann-Whitney-Wilcoxon W test was chosen because the Shapiro-Wilk test showed that at least one of the indicators under study did not have a normal distribution. Mann-Whitney-Wilcoxon W test is a non-parametric variant of the test of the identity of the means of two independent random sets (x_1, x_2, … x_n) and (y_1, y_2, … y_m) with a different number of elements. The null hypothesis states that the data samples have identical means (medians). The alternative hypothesis states that the data samples do not have identical means (medians). The test statistic to assess the normality of the data is the W statistic, which is defined as:

$$W = \frac{R^+ - \frac{1}{2}n_x n_y}{\sqrt{\frac{n_x n_y}{12}\left(n_x + n_y + 1\right)}} \tag{4}$$

where R^+ is the smaller sum of the sequence numbers. If $|w| > W_\alpha$ i.e. the critical value of the *N(0; 1)* distribution, we reject the null hypothesis of agreement of trait values at a given significance level. This means that the difference between the pair of means (medians) is statistically significant. STATGRAPHICS Centurion XVIII software was used to test the hypotheses and all tests were performed at α = 5% significance level.

Step 4: Create a questionnaire. The aim of this research was also to analyze data collected from young people who are most likely to be the main users in the Czech gaming industry. According to the CZSO survey (2018), approximately 68% of 16-24 years old people play computer games. This survey further adds that the frequency of playing computer games dropped to half for the 25-34 age group and further decreased as the population aged (CZSO, 2022). In order to determine the impact of the COVID-19 pandemic on users' interest in video games, a questionnaire survey was conducted among students at a selected university. The respondents of the survey were first-year undergraduate students of the Faculty of Economics at the TUL. The collected data were anonymized, and the results were presented in a summary form. The survey was conducted from November 15, 2022, to December 15, 2022. The aim was to reach as many respondents as possible, so the electronic questionnaire was sent via email to 394 first-year full-time bachelor students. Data collection was carried out using an anonymous questionnaire containing 6 questions. The questionnaire consisted of closed-ended questions with the option to mark one or more answers. There was only one open-ended question in the questionnaire. Four questions measured the respondents' attitudes toward the issue under study, and two questions were of an identifying nature and characterized the respondents involved in the research. In the introductory part of the questionnaire developed, a request for completion was made along with a brief justification of the research as well as information about the time of completion.

4. Results

4.1. Financial Impact of the COVID-19 Pandemic

In the first part of the research, selected financial indicators of the 15 most famous Czech gaming companies were monitored. Table 1 summarizes the turnover of gaming companies for the years 2018-2020.

Table 1. Turnover of the most important Czech gaming companies in 2018-2020 (thous. CZK) (own processing based on data from the Department of Justice (2022))

Company	2018	2019	Annual change	2020	Annual change
Bohemia Interactive Studio	17,990	41,657	132%	55,970	34%
SCS Software	497,091	579,603	17%	791,024	36%
Warhorse Studios	1,076,059	462,523	*-57%*	249,526	*-46%*
2K Czech	127,734	178,150	39%	255,691	44%
Amanita Design	45,221	93,051	106%	104,558	12%
Madfinger Games	126,045	121,296	*-4%*	95,564	*-21%*
Geewa	166,787	324,062	94%	372,755	15%
Grip Digital	30,918	21,996	*-29%*	53,099	141%
Beat Games	120,968	801,760	563%	1,441,205	80%
Cenega Czech	13,462	4,959	*-63%*	2,071	*-58%*
Cinemax	4,167	3,515	*-16%*	3,892	11%
DynamicDust	212	41	*-81%*	53	29%
Gammosaur	677	30	*-96%*	516	1,620%
McMagic Productions	2,662	722	*-73%*	764	6%
Wargaming Prague	2,590,576	282,083	*-89%*	423,735	50%

Table 1 shows that in 2019, a total of 9 companies recorded a decrease in their turnover compared to 2018. In 2020, only three companies (Warhorse Studios, Madfinger Games and Cenega Czech) recorded a decrease in turnover compared to 2019.

Table 2 summarizes the profitability indicators for 2018. Table 2 shows that only one company made a loss in 2018 (Geewa). The other companies made a profit. The highest net profit was recorded for Warhorse Studios. Table 2 further shows the values of ROA, ROE and ROS ratios. The ROA ratio came out positive except for Geewa. The highest value was achieved by DynamicArt, which earned a net profit of 1,275 cents on 1 crore of invested capital in 2018. The ROE indicator came out positive with the exception of Geewa and DynamicArt. The negative value for Geewa was due to the loss. The negative value for DynamicArt was due to negative equity. The best equity appreciation was achieved by Warhorse Studios, which managed to appreciate one invested crown by 108 cents. The last indicator evaluated is ROS. ROS is positive for all companies except Geewa. The last row of Table 2 presents the mean and median of the above financial performance indicators.

Table 2. Profitability indicators of gaming companies in 2018 (own processing based on data from the Department of Justice (2022))

Company	EAT (thous. CZK)	ROA	ROE	ROS
Warhorse Studios	521,85	81.4%	108.2%	47.6%
Beat Games	81,168	83.3%	108.1%	67.1%
Bohemia Interactive Studio	1,822	28.0%	55.1%	10.3%
Wargaming Prague	9,574	10.1%	48.2%	3.6%
GAMMOSAUR	112	9.5%	47.5%	16.5%
GRIP Digital	6,62	31.8%	38.8%	21.4%
SCS Software	298,123	36.5%	37.6%	63.1%
CENEGA CZECH	13,096	20.2%	25.4%	8.2%
Amanita Design	13,784	16.6%	18.3%	29.6%
McMagic Productions	19	6.8%	6.8%	0.7%
MADFINGER Games	9,405	4.3%	4.5%	7.5%
CINEMAX	26	0.2%	3.1%	0.6%
2K Czech	1,745	0.8%	1.3%	1.0%
DynamicArt	102	12.7%	-8.3%	48.1%
Geewa	-14,504	-23.5%	-133.0%	-8.7%
Average	49,461	116.7%	20.7%	18.7%
Median	6,620	10.1%	18.3%	8.2%

Table 3 summarizes the profitability indicators for 2019. Table 3 shows that five companies were loss-making in 2019 (2K Czech, DynamicArt, GAMMOSAUR, Geewa, and GRIP Digital). The other companies made a profit. The highest net profit was recorded by Beat Games. Table 3 below shows the ROA, ROE, and ROS ratios. With the exception of the five companies mentioned above, the ROA ratio was positive. The highest value was achieved by Beat Games, which earned 85.8 cents of net profit from 1 cent of invested capital in 2019. The ROE indicator came out positive with the exception of 2K Czech, Geewa, and GRIP Digital. The positive ROE for DynamicArt and GAMMOSAUR was due to dividing the

loss and negative equity value. The last row of Table 3 presents the mean and median of the above-mentioned financial performance indicators.

Table 3. Profitability indicators of gaming companies in 2019 (own processing based on data from the Department of Justice (2022))

Company	EAT (thous. CZK)	ROA	ROE	ROS
GAMMOSAUR	-286	-38.9%	572.0%	-953.3%
Beat Games	1,844,667	85.8%	126.5%	230.1%
Bohemia Interactive Studio	4,07	34.8%	89.1%	9.8%
Warhorse Studios	210,203	54.3%	66.2%	45.4%
Wargaming Prague	16,479	12.5%	45.4%	5.8%
Amanita Design	39,974	28.7%	35.0%	42.5%
SCS Software	298,456	32.2%	33.0%	53.5%
CINEMAX	682	5.8%	25.1%	19.4%
CENEGA CZECH	2,363	4.4%	4.8%	2.4%
McMagic Productions	12	4.1%	4.1%	1.7%
DynamicArt	-40	-500.0%	3.1%	-97.6%
MADFINGER Games	36	0.0%	0.0%	0.0%
2K Czech	-1,176	-0.6%	-0.9%	-0.5%
GRIP Digital	-2,119	-11.5%	-14.2%	-9.6%
Geewa	-4,272	-4.6%	-64.5%	-1.3%
Average	162,040	-27.7%	61.7%	-55.0%
Median	36	4.1%	4.8%	1.7%

Table 4 summarizes the profitability indicators for 2020. Table 4 shows that four firms are loss-making in 2020 (GAMMOSAUR, Geewa, MADFINGER Games, and McMagic Productions).

Table 4. Profitability indicators of gaming companies in 2020 (own processing based on data from the Department of Justice (2022))

Company	EAT (thous. CZK)	ROA	ROE	ROS
Bohemia Interactive Studio	2,276	18.7%	82.0%	4.1%
GAMMOSAUR	-227	-50.1%	81.9%	-44.0%
GRIP Digital	16,01	33.1%	51.7%	30.2%
SCS Software	440,887	36.2%	37.9%	57.5%
Wargaming Prague	17,909	9.4%	33,0%	4.2%
Warhorse Studios	145,446	29.2%	31.4%	58.2%
Amanita Design	34,551	23.3%	27.3%	32.6%
CENEGA CZECH	7,272	9.5%	13.5%	6.7%
CINEMAX	216	1.8%	5.7%	5.5%
2K Czech	7,392	3.5%	5.1%	2.2%
Beat Games	56,24	2.8%	3.7%	3.9%
DynamicArt	3	100.0%	-0.2%	5.7%
McMagic Productions	-18	-6.6%	-6.6%	-2.4%
MADFINGER Games	-16,176	-14.6%	-15.5%	-16.9%
Geewa	-10,722	-10.5%	-20.7%	-2.9%
Average	19,838	10.1%	16.2%	6.4%
Median	7,272	3.5%	5.7%	4.2%

The other companies were making a profit. The highest net profit was recorded for SCS Software. The ROA indicator came out positive with the exception of the four companies mentioned above. The positive ROE for GAMMOSAUR was due to the division of the loss and the negative equity value. On the other hand, DynamicArt achieved a negative ROE despite a positive net profit. This is due to the negative equity value. The last row of Table 4 presents the mean and median of the above financial performance ratios.

The differences between the medians of the observed indicators are not statistically significant at the alpha 5% level (see Table 5). Thus, there was no statistically confirmed difference in the values of the financial indicators in the years before and during the COVID-19 pandemic.

Table 5. Mann-Whitney (Wilcoxon) W-test to Compare Medians (P-Values)

Indicator	Year 2018 - Year 2019	Year 2018 - Year 2020	Year 2019 - Year 2020
Turnover	W = 113.0 (1.00000)	W = 115.0 (0.933881)	W = 117.0 (0.868221)
EAT	W = 94.0 (0.455300)	W = 107.0 (0.835700)	W = 119.0 (0.803458)
ROA	W = 80.0 (0.184409)	W = 85.5 (0.2716400)	W = 116.0 (0.900966)
ROE	W = 107.5 (0.851913)	W = 97.0 (0.5338270)	W = 102.5 (0.693514)
ROS	W = 82.0 (0.213373)	W = 84.0 (0.2454840)	W = 116.0 (0.900966)

4.2. Impact of the COVID-19 Pandemic on Users

The questionnaire had 208 visits and 57 of them ended with the questionnaire not being run. A total of 151 respondents started the questionnaire and none of them closed the questionnaire before it was completed. The overall success rate of completing the questionnaire is therefore 38%. It is worth noting that such a return rate, according to some experts, may impair the generalizability of the survey findings. Before completing the questionnaire, respondents were advised that the questionnaire would take them a maximum of 5 minutes to complete. In fact, 74.15% of respondents took < 1 minute to complete the questionnaire, 22.47% took 1-2 minutes and 2.8% took 2-5 minutes. Only 0.56% of the respondents took more than 5 minutes to complete the questionnaire.

The basic categorization of the data - respondents by gender and age – is presented for clarity in the introductory part of the research results, in the following figures 1 and 2. Questions 3 to 6 are analytical questions.

Of the 151 respondents, 54.3% of women and 45.7% of men responded in relative terms, i.e., 82 women and 69 men in absolute terms (see Figure 1). Follow-up question 2 asked for the age of the respondent.

Of the 151 respondents, 31.13% were between the ages of 20-21 years, specifically 47 respondents. The age group of 22-23 years was 30.46% of respondents and the age group of 18-19 years was 20.53% of respondents. Further, 4 respondents were in the age group of 26-27 years and 2 respondents were in the age group of 28-29 years. There was no representation of respondents under the age of 18 years as these respondents are not college students and were not included in the survey as shown in Figure 2.

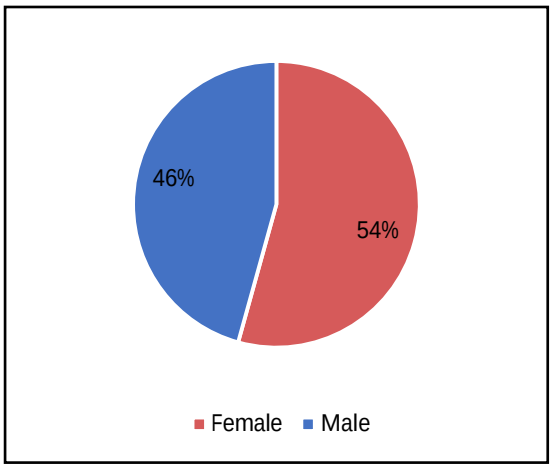

Figure 1. Gender of respondents

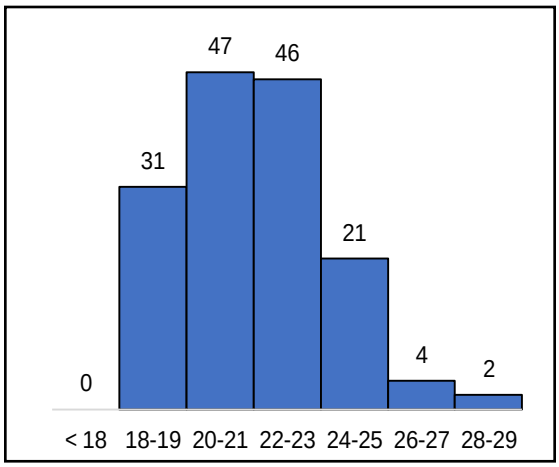

Figure 2. Age of respondents

Question 3 of the survey focused on how often students played video games BEFORE the COVID-19 pandemic. The results are shown in Figure 3. Figure 3 shows that before the COVID-19 pandemic, most students i.e., video game users played several times a week (38 responses). The second most common response was "rarely" (35 responses). The figure shows that the third and fourth ranked responses were several times a day (22 responses) and once a day (21 responses).

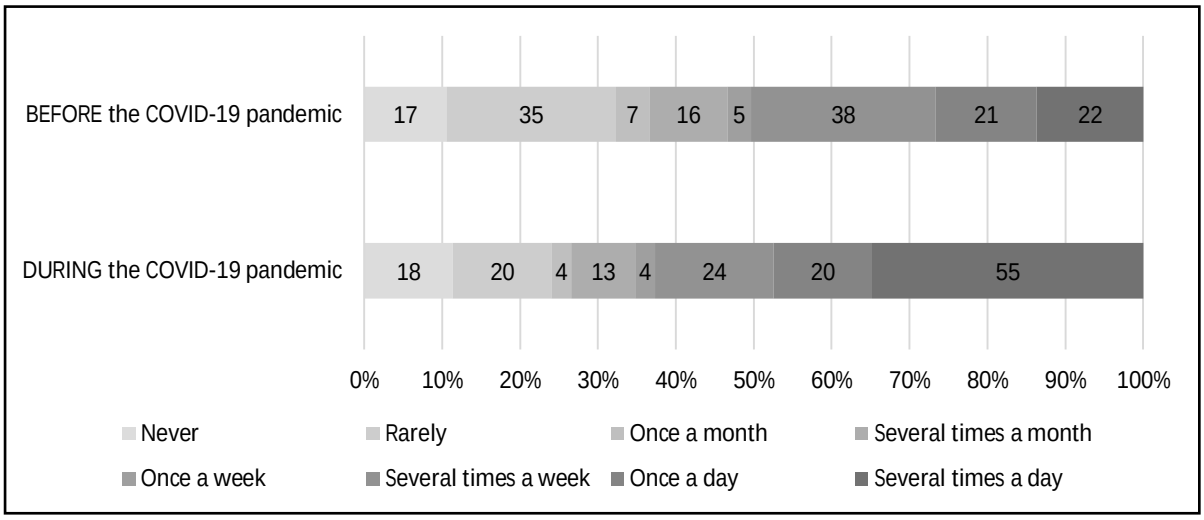

Figure 3. How often did you play games BEFORE and DURING the COVID-19 pandemic?

Question 4 focused on how often students played the video game DURING the COVID-19 pandemic. Multiple answers could be selected for this question. The results are also shown in Figure 3. Figure 3 shows that during the COVID-19 pandemic, most students, i.e., video game users, played several times a day (55 responses). The second highest response was "several times a week" (24 responses). The answer "rarely" showed a significant decrease compared to the previous question 3 (only 20 responses). Figure 3 shows the gaming habits of respondents before and during the first wave of the COVID-19 pandemic and demonstrates a clear shift towards a higher frequency of gaming. For example, Figure 3 shows that 13.6% of respondents reported playing video games several times a day before the pandemic, while this proportion increased to 34.8% during the pandemic. At the other

end of the scale, 21.7% of respondents said they rarely played games before the outbreak, while this proportion dropped to 12.6% during the pandemic.

Question 5 focused on what type of games users preferred BEFORE the COVID-19 pandemic. The results are shown in Figure 4. Figure 4 shows that before the COVID-19 pandemic, most students i.e., users played mobile games (59 responses). The second response was "computer games - free-to-play" (45 responses). In third place was "computer games - buy-to-play" (43 responses). A total of 21 respondents did not play any of the above types of video games and 14 respondents played a combination of all the above types of video games.

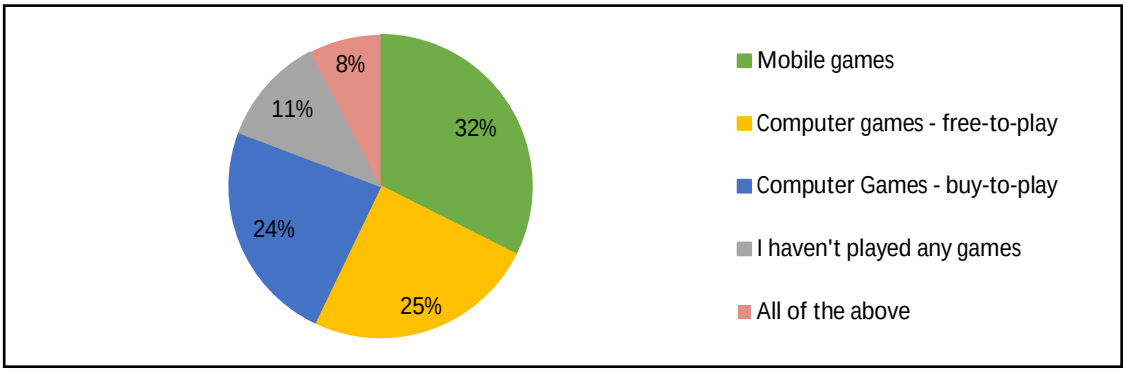

Figure 4. What type of video games did you prefer BEFORE the COVID-19 pandemic?

Question 6 focused on what type of games were preferred by users DURING the COVID-19 pandemic. Multiple answers were possible for this question. The results are shown in Figure 5. Figure 5 shows that during the COVID-19 pandemic, most students played computer games - free-to-play (56 responses). The second response was "mobile games" (53 responses). In third place was "computer games - electronic license" (49 responses). A comparison of the two graphs shows a shift of some users towards computer games - free-to-play and buy-to-play. During the COVID-19 pandemic, interest in mobile games declined.

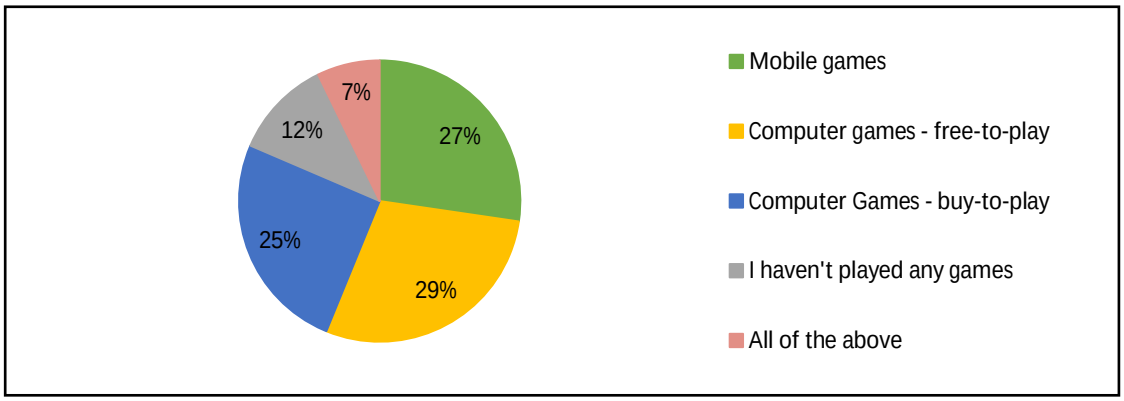

Figure 5. What type of video games did you prefer DURING the COVID-19 pandemic?

5. Discussion

The research found that Czech gaming companies recorded a higher turnover in 2020 compared to 2019. A similar conclusion was reached by Şener and Yalçın (2021). The ratios that focused on the profitability of individual companies fluctuated over the years. The

differences between the medians of the indicators studied were not statistically significant in the years 2018 to 2020. Thus, the difference in the values of financial ratios in the years before and during the COVID-19 pandemic was not statistically confirmed.

The questionnaire survey revealed that there was a higher interest among students in computer games during the first wave of the COVID-19 pandemic. Students also responded that they played games several times a day and several times a week during the pandemic. The NPD Group (2022) and authors Barr and Copeland-Stewart (2021) came to a similar conclusion.

For better and more accurate results, it would be desirable to supplement the research with additional questions that would focus more on the main reasons for the higher interest among students in video games. It is also important to note that the research was only conducted for the first wave of the COVID-19 pandemic. Future research should focus on the year 2021, which has also been associated with strict anti-epidemic measures.

6. Conclusions

The aim of the research was to investigate in more detail the impact of the first wave of the COVID-19 pandemic on Czech companies operating in the gaming industry. The research was primarily based on the analysis of secondary financial data on Czech gaming firms. The research was further supplemented by the collection of primary data, which was obtained through a questionnaire survey among first-year students of the Faculty of Economics, Technical University of Liberec.

Based on the examination of selected financial indicators, an increased turnover of gaming companies in 2020 was found. It can be assumed that the increased turnover was because of increased user interest in video games during the first wave of the COVID-19 pandemic. However, the research results did not support the hypothesis that gaming companies achieved better profitability in 2020 compared to 2019. The differences between the medians of the observed indicators are not statistically significant. Mann-Whitney W-test did not confirm the difference in the values of financial indicators in the years before and during the COVID-19 pandemic. Profitability as measured by the traditional metrics of EAT, ROA, ROE, and ROS were approximately the same in all years.

A questionnaire survey conducted among first-year undergraduate students revealed an increased interest in video games during the first wave of the COVID-19 pandemic. Most users preferred mainly free-to-play computer games during the COVID-19 pandemic and buy-to-play games. On the other hand, the research showed a slight decrease in interest in mobile games.

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Conflict of interest: none.

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The Promotion Effect of Minimum Wage on Enterprise Digital Transformation

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Abstract: In the digital economy era, the factors influencing enterprise digital transformation have become the focus in the study. Based on the minimum wage perspective, this paper uses the data of China listed companies and minimum wage to study the impact of minimum wage on enterprise digital transformation. The results show that the rise of minimum wage has accelerated the process of enterprise digital transformation, and this conclusion still hold true after robustness test and endogenous treatment. Mechanism analysis shows that the rise of minimum wage promotes enterprise digital transformation through innovation incentive effect. The heterogeneity analysis shows that for non-state enterprises, high-tech enterprises and China eastern enterprises, the minimum wage plays a more significant role in promoting enterprise digital transformation. The conclusion provides a useful reference for enterprises to effectively promote digital transformation and the government to reasonably set the minimum wage standard in the digital economy era.

Keywords: digital transformation; minimum wage; corporate governance

JEL Classification: D21; G30; O30

1. Introduction

Nowadays, digital technology has led a new round of technological and industrial transformation, and digital economy has become a new direction of global economic development. According to the White Paper on the Development of Digital Economy in China (2022), the size of China's digital economy has reached 45.5 trillion yuan in 2021, with a growth rate of 16.2%, accounting for 39.78% of the GDP, showing a huge growth power and application space. Industry digitalization has become the main engine of the digital economy development, and the digital economy is increasingly driven by consumer Internet to industrial Internet. Enterprises as one of the most important micro-subjects of digital economy application, digital technology and digital services play an increasingly important role in enterprise governance. The ABCD structure of enterprise digital transformation, which is based on Artificial Intelligence, Blockchain, Cloud Computing and Big Data, has profoundly changed the production mode, organizational form and business model of traditional enterprises, showing excellent prospects and growth momentum, and is increasingly becoming the key breakthrough for global enterprises to gain competitive advantage. Especially under the background of COVID-19 pandemic and post-epidemic economic recovery, the enterprise digital transformation is more important and urgent:

contactless office and e-marketing became the main ways for enterprises to maintain operation during the epidemic, online office improved the efficiency of information transmission within enterprises, reduced the risk of income interruption for employee, and smart logistics ensured the smooth supply chain of enterprises under the epidemic. Facing the post-epidemic business recovery, digital technology plays a more critical role and has a broader application scenario. Mobile Internet technology breaks through the physical boundary of enterprise business expansion, which helps to expand the target market and gain a broader customer group. Big data and artificial intelligence help to accurately lock the target customers and accurately build user portraits. Industrial robot and smart customer service in the front and back end of production respectively prevent enterprises from falling into shutdown due to epidemic situation. In addition, commercial banks and other financial institutions make use of financial technology to precisely evaluate credit risk, give full play to inclusive finance's advantages, and can provide credit loan with low threshold and high efficiency, helping enterprises to realize post-epidemic recovery. In fact, in today's world, where all kinds of uncertainties are rising, data flow has become a production factor as important as capital flow, and the enterprise digital transformation has become an urgent issue that all kinds of enterprises must face.

The enterprise digital transformation not only has great affect in the field of practice, but also become the focus of academic attention. Tapscott (1996) put forward the concept of "digital economy" earlier, pointing out that the internet and information technology will reshape the traditional definitions of economy, wealth creation, business organization and institutional structure, and digital economy is a new economy that presents information flow digitally. As one of the most important micro-subjects of social and economic operation, enterprises play a key role in the tide of digital economy. Based on the connotation of Liu et al. (2021), this paper defines enterprise digital transformation as the change of enterprise management mode and thinking. Compared with the traditional industrialization system, enterprise digital system introduces digital technology into enterprise management structure, promotes the systematic reshaping of enterprise information structure, management mode, operation mechanism and production process, and finally realizes the change from industrialization management mode to digital management mode.

The enterprise digital transformation will produce significant economic effects. Acemoglu (2003) found that the change of technological and the change of factor share will give new value to the data, which may cause a series of economic impacts on the operating cost, technological innovation and even capital market performance. Mikalef and Pateli (2017), using the survey data of 274 international companies, found that information technology has improved the adjustment agility of enterprise market value and operation, thus enhancing its market competitiveness. The above research focuses on the economic effects of enterprise digital transformation. However, what factors drive the enterprise digital transformation are also worthy of attention. Zeng (2022) divided the driving factors of enterprise digital transformation into three categories: technology-driven theory, organization-driven theory and environment-driven theory. First, Technology-driven theory holds that enterprise digital transformation is the result of technological progress, and it is a

highly dynamic process of continuous iteration in learning and practice (Chanias et al., 2019). The complexity, uncertainty, testability and observability of technology itself will all have an impact on enterprise digital transformation (Maroufkhani et al., 2020). Secondly, Organization-driven theory provides a possible explanation for digital transformation from the internal factors of enterprises. It has been found that the senior managers' support is the key factor that affects enterprise digital transformation (Maroufkhani et al., 2020). And enterprises' financial situation will also have an impact on the digital transformation. Higher financialization and high leverage ratio of enterprises will inhibit enterprise digital transformation (Huang et al., 2022; Du et al., 2022). These literatures are mainly based on the internal characteristics of enterprises to study the impact on digital transformation. However, the external environment faced by enterprises is also an important factor affecting the process of digital transformation, which corresponds to the environment-driven theory. Mao et al. (2022) found that the construction of transportation infrastructure represented by high-speed railway can significantly promote enterprise digital transformation, and the convenient transportation network can improve entrepreneurs' access to digital technology, alleviate the shortage of digital professionals, and accelerate enterprise digital transformation. Zeng (2022), taking forward-looking effective tax rate as the starting point, found that tax incentive policy can promote digital transformation by easing corporate financing constraints and strengthening entrepreneurial orientation.

As an important system design in the world's major economies for a long time, whether the minimum wage still meets the needs of enterprise operation and labor market in the digital economy era deserves attention. The existing literature on the economic effect of minimum wage mainly focuses on the influence of workers' income distribution, employment choice and enterprise behavior. Avram et al. (2019) discussed the influence of minimum wage on the competitiveness and employment of small and medium-sized enterprises under the background of digital technology change from the perspective of digital economy for the first time. It was believed that the application of digital technology and minimum wage growth could enhance the competitiveness of small and medium-sized enterprises, and had significant employment creation effect. In this paper, we discuss the impact of minimum wage on enterprise digital transformation, and one of the most closely related literature is the research on the minimum wage and the application of industrial robots. Lordan and Neumark (2018) found that the minimum wage reduced the employment share of low-skilled workers, and led enterprises to adopt industrial robots instead of low-skilled workers. Similarly, Freeman et al. (2020) found that the minimum wage significantly increased the usage rate of robots, and an industrial robot could replace about 15 workers, and this effect was more significant in labor-intensive enterprises and large enterprises. In fact, for enterprises, the increase of minimum wage will significantly change their preferences and constraints, affect their economic decisions, and then affect enterprise digital transformation.

The minimum wage's influence on enterprise digital transformation is mainly realized through innovation incentive effect. On the one hand, the increase of the minimum wage intensifies the business pressure of enterprises, forcing them to open up new profit margins through R&D and innovation. On the other hand, the increase of minimum wage can not

only increase the income of low-skilled labor and unskilled labor, but also have obvious synergistic growth effect: according to the theory of organizational justice, the wage gap within enterprises may remain relatively stable, and the increase of minimum wage will also raise the wage level of medium-skilled and high-skilled labor (Gregory & Zierahn, 2020). This overall increase in wage level caused by the increase of minimum wage has played an efficiency wage effect to a certain extent. Higher wage level can motivate employees to work harder, while avoiding the loss of high-skilled labor force (Shapiro & Stiglitz, 1984), which is helpful to improve the productivity and innovation of enterprises. In addition, the increase of workers' income caused by the minimum wage also has the demand creation effect. The propensity to consume of workers due to rising wages will be higher than that of profit-takers. The expansion of local market scale has improved the effective demand of enterprises and reduced the innovation risk of enterprises, so they will more actively carry out innovation activities (Li, 2017).

Compared with previous literatures, the possible marginal contributions of this paper are as follows. Firstly, in terms of research perspective, the existing literature has not paid direct attention to the economic impact of minimum wage on enterprise digital transformation. Based on the perspective of minimum wage, this paper studies the influence and mechanism on enterprise digital transformation, enriching the existing literature. Secondly, in terms of data, we collect China cities' minimum wage data manually, and use the digital transformation data of enterprises based on text quantitative analysis. Compared with the previous qualitative research on enterprise digital transformation, the quantitative analysis in this paper provides a more reliable practical example. Thirdly, in terms of practical value, the research conclusion provides beneficial enlightenment for minimum wage standard setting and its economic effect evaluation under the background of digital economy era, and provides reference for enterprises' production decision-making and digital transformation.

2. Methodology

2.1 Data Source

The data in empirical part of this paper mainly involves three aspects: the minimum wage data of the city where the company is located, the digital transformation data of listed companies and other financial characteristics data of listed companies. As there is no ready-made database for the minimum wage data of China cities, this paper manually collects the minimum wage data from local government websites and official news announcements. The digital transformation data of listed companies comes from the keyword database of "digital transformation" constructed by Wu et al. (2021) based on Python crawler of enterprise annual reports, and the financial characteristic data of listed companies comes from CSMAR China listed company database. The time interval in this paper is from 2008 to 2020, excluding the financial industry and listed companies in ST state, as well as the companies with less than 5 years' listed time. And we have also dropped the sample with serious missing values. All continuous variables have been truncated (winsorize) at the level of 1% and 99% to avoid the influence of extreme values.

2.2 Indicator Selection

Explained variable. The explained variable in this paper is enterprise digital transformation (DTR). Traditional literature mainly describes enterprise digital transformation qualitatively, but it is difficult to investigate the quantitative characteristics. And some papers construct the dummy variable of whether enterprises are undergoing digital transformation, but it still can't describe the intensity and time varying trend of enterprise digital transformation. Most of the latest researches are based on the text mining of company annual reports to analyze enterprise digital transformation. Based on Wu et al. (2021) open-source database, this paper depicts the degree of digital transformation from the word frequency of "enterprise digital transformation" in the annual reports of listed companies, obtains the annual reports of China A-share listed companies through Python crawler function, and screens the character-words. We divide the source of character-words into "bottom technology application" (including artificial intelligence, blockchain, cloud computing and big data) and "technical practice application". Specific character-words are shown in Table 1. The above categories of character-words are summed up as the total word frequency of enterprise digital transformation. Considering that the word frequency data has obvious right-skewed feature, this paper adds 1 to the word frequency of enterprise digital transformation and then takes logarithm as the final explained variable.

Table 1. Character-words of enterprise digital transformation

	Characteristic words
Artificial Intelligence	Artificial intelligence, business intelligence, image understanding, investment decision support system, intelligent data analysis, intelligent robot, machine learning, deep learning, semantic search, biometric technology, face recognition, speech recognition, identity verification, automatic driving, natural language processing
Blockchain	Blockchain, digital currency, distributed computing, differential privacy technology, intelligent financial contract
Cloud Computing	Cloud computing, stream computing, graph computing, in-memory computing, multi-party secure computing, brain like computing, green computing, cognitive computing, converged architecture, billion-level concurrency, EB-level storage, Internet of Things, cyber-physical systems.
Big Data	Big data, data mining, text mining, data visualization, heterogeneous data, credit reporting, augmented reality, mixed reality, virtual reality
Application of digital technology	Mobile Internet, industrial Internet, mobile internet, Internet medical care, e-commerce, mobile payment, third-party payment, NFC payment, smart energy, B2B, B2C, C2B, C2C, O2O, network connection, smart wear, smart agriculture, intelligent transportation, smart medical care, smart customer service, smart home, smart investment, smart travel, smart environmental protection, smart grid, Intelligent marketing, digital marketing, unmanned retail, internet finance, digital finance, Fintech, financial technology, quantitative finance, open banking

Explanatory variable. The core explanatory variable in this paper is the minimum wage (Min_wage), which is expressed by the logarithm of the minimum wage in the city where the listed company is located. In order to alleviate the endogenous problem, and considering that the minimum wage may have a lag effect on enterprise behavior and decision-making, this paper processes the minimum wage data for a lag period.

Control variables. This paper also controls the following characteristic variables that may affect enterprise digital transformation: the age of the company (Age), which is expressed by subtracting the registered year of the company from the sample year and then taking the logarithm. The size of the company (Size), which is expressed by the logarithmic value of the company's total assets. Liquid ratio (Liquid), which is expressed by dividing the company's liquid assets by its liquid liabilities. Asset-liability ratio (Lever), which is expressed by dividing the total liabilities by the total assets. Cash abundance (Cash), which is expressed by dividing the balance of cash and cash equivalents at the end of the year by total assets. Return on assets (ROA), which is expressed by the ratio of net profit to total assets in the current year. Tobin's Q (Tobinq), which is expressed by dividing the company's market value by its total assets. P/E ratio (PE), which is expressed by the percentage of the company's stock price divided by earnings per share. Ownership concentration (Top1), which is expressed by the shareholding ratio of the largest shareholder. Proportion of independent directors (Indep), which is expressed by the proportion of independent directors to board members. Ownership nature (Soe), state-owned enterprises are assigned 1, and non-state-owned enterprises are assigned 0. Descriptive statistics include observation number, average, standard deviation, minimum value and maximum value. The detailed results are shown in Table 2.

Table 2. Descriptive statistics of variables

Variable	Observation	Average	Std. Dev.	Min	Max
DTR	29,030	2.5402	1.3930	0.0000	7.3119
Min_wage	29,030	7.2308	0.3480	6.2344	7.7915
Age	29,030	2.8754	0.3145	1.7918	4.1431
Size	29,030	22.1293	1.3188	19.2176	26.0591
Liquid	29,028	2.3348	2.4687	0.2352	17.3954
Lever	29,028	0.4425	0.2148	0.0508	1.0055
Cash	29,028	0.1589	0.1268	0.0074	0.6853
ROA	29,028	0.0338	0.0696	-0.3271	0.2127
Tobinq	28,336	2.1339	1.4901	0.8719	9.7412
PE	28,336	0.7503	1.3884	0.0000	9.4410
Top1	29,030	0.3446	0.1491	0.0880	0.7510
Indep	29,028	0.3749	0.0559	0	1
Soe	29,030	0.3928	0.4884	0	1

2.3. Model Building

In this paper, we set a two-way fixed effect model for benchmark estimation, and the specific form is shown in formula (1).

$$DTR_{it} = \gamma_0 + \gamma_1 Min\_wage_{j\,t-1} + \gamma_2 Controls_{it} + Ind + Year + \varepsilon_{it} \quad (1)$$

Among them, the explained variable *DTR* represents enterprise digital transformation, the core explanatory variable *Min_wage* represents the minimum wage, and the *Controls* represents the control variable matrix. In order to reduce the unobservable heterogeneity, this paper also controls industry fixed effect (*Ind*) and time fixed effect (*Year*), ε represents random error term. The subscript *i* denotes the sample enterprise, *j* denotes the city where the

enterprise is located, and *t* denotes the sample year. In addition, this paper uses robust standard error in regression. If the minimum wage accelerates the process of enterprise digital transformation, the regression coefficient γ_1 is expected to be significantly positive.

3. Results

3.1. Benchmark Regression Results

In order to investigate the impact of minimum wage increase on enterprise digital transformation, we use formula (1) for benchmark estimation, and the regression results are shown in Table 3. Columns (1)-(2) report the regression results without adding fixed effects, and columns (3)-(4) report the regression results after adding fixed effects of time and industry. It can be seen that the regression coefficient of minimum wage is significantly positive at the level of 1%, indicating that the rise of minimum wage has promoted enterprise digital transformation.

Table 3. Benchmark regression results

	(1)	(2)	(3)	(4)
Min_wage	1.7219***	1.2447***	0.2938***	0.2707***
	(0.0297)	(0.0420)	(0.0820)	(0.0788)
Age		0.2018***		-0.4637***
		(0.0558)		(0.0557)
Size		0.2678***		0.2233***
		(0.0173)		(0.0155)
Liquid		-0.0200***		-0.0168***
		(0.0050)		(0.0050)
Lever		-0.4602***		-0.3390***
		(0.0798)		(0.0739)
Cash		0.2530***		0.1855**
		(0.0791)		(0.0753)
ROA		-0.0739		0.1733*
		(0.1049)		(0.0985)
Tobinq		0.0143**		0.0029
		(0.0062)		(0.0067)
PE		-0.0093**		-0.0031
		(0.0041)		(0.0041)
Top1		-0.6155***		-0.2988***
		(0.1189)		(0.1069)
Indep		-0.2855*		-0.2871*
		(0.1612)		(0.1586)
Soe		-0.2454***		-0.1817***
		(0.0456)		(0.0413)
Cons_	-9.8588***	-12.2632***	-0.7526	-3.7420***
	(0.2144)	(0.3575)	(0.5705)	(0.6324)
Ind_fixed	NO	NO	YES	YES
Year_fixed	NO	NO	YES	YES
N	29,030	28,333	29,030	28,333
R^2	0.3403	0.3767	0.3839	0.4036

Note: ***, **, * are significant at the level of 1%, 5% and 10% respectively. Robust standard error is in parentheses. The following tables are the same.

3.2. Robustness Test

In order to enhance the reliability of the benchmark regression conclusion, we conducted a series of robustness tests. First, we use principal component factor analysis to replace the measurement of the explained variables. The enterprise digital transformation index used in the benchmark regression is obtained by simply adding up the word frequency and then taking the logarithm. This results in equal weight for each sub-indicator, which may lead to overestimation or underestimation of the importance of some indicators. Therefore, we use the principal component factor analysis method to construct enterprise digital transformation index. The average value of the five indicators KMO test is 0.7383, which indicates that the sample is suitable for factor analysis. According to the principle that the eigenvalue is greater than 1, this paper finally retains one factor as the proxy variable of digital transformation. The results are shown in the first column of Table 4. The coefficient is significantly positive at the level of 1%, which confirms the basic conclusion that the increase of minimum wage can promote enterprise digital transformation.

Secondly, considering that Poisson regression is a model for analyzing the dependent variable of count data, so we replace the measurement model with Poisson regression, and directly uses the original word frequency of enterprise digital transformation as dependent variable. As shown in the second column of Table 4, the coefficient is still significantly positive at 1%. Thirdly, in order to reduce the estimation error caused by the sample self-selection deviation, this paper uses Bootstrap estimation to realize the unbiased gradual population distribution. The estimation results of self-sampling 500 times are shown in column 3, and the regression results are consistent with the benchmark regression. Fourthly, considering the impact of the international financial crisis in 2008 on business operations, in order to eliminate the lasting impact of the financial crisis, we exclude the samples in 2008, 2009 and 2010. The results are shown in column 4 of Table 4, and the regression coefficient is still positive at the 1% level. The above robustness tests all confirm the credibility of the benchmark regression conclusion.

The endogeneity caused by missing variables may still affect the estimation results. So, we use the instrumental variable method to alleviate the endogenous estimation bias. Referring to Mayneris et al. (2018), we choose the minimum wage data with three lag periods as the instrumental variable. The estimation results by using the two-stage least square method are shown in Table 4. The first-stage estimation results show that instrumental variables are significantly positively correlated with core explanatory variables. The p value of the first stage F value is 0.0000, which rejects the null hypothesis of weak instrumental variables. The p value of Kleibergen-Paap rk LM statistic is 0.0000, which rejects the null hypothesis of under identification, indicating the effectiveness of tool variables. The estimation result of the second stage shows that minimum wage still significantly promotes enterprise digital transformation at the level of 1%. In a word, the conclusion of instrumental variable method is consistent with the benchmark regression.

Table 4. Robustness test results

	PCF	Poisson	Bootstrap	Change Year	IV	
					Min_wage	DTR
Min_wage	0.3124*** (0.0924)	0.7453*** (0.0626)	0.2707*** (0.0799)	0.3088*** (0.0786)	0.8735*** (0.0033)	0.6799*** (0.0504)
Controls	YES	YES	YES	YES	YES	YES
Ind_fixed	YES	YES	YES	YES	YES	YES
Year_fixed	YES	YES	YES	YES	YES	YES
N	28,333	28,333	28,333	25,507	21,629	21,629

3.3. Mechanism Analysis

The rise of minimum wage has promoted enterprise digital transformation, but its mechanism remains to be tested. Minimum wage reduces the enterprises' profit margin, forcing enterprises to increase R&D and innovation investment to seek new profit sources. Moreover, the increase of minimum wage leads to the improvement of the overall wage level in enterprises, which to some extent plays the role of efficiency wage, encourages employees to improve production efficiency, and is beneficial to R&D and innovation activities. In addition, the increase of minimum wage will also raise the workers' consumption demand, which will reduce the risk of enterprise innovation. And the increase of enterprise innovation investment will help to promote the process of digital transformation. In order to investigate this effect, this paper uses the ratio of enterprise R&D input to operating income (R&D Input) and the ratio of R&D Staff to the total number of employees (R&D Staff) to measure enterprise innovation input. The mechanism analysis results are shown in Table 5. The regression coefficients of minimum wage to enterprise innovation investment are all significantly positive at the level of 1%, indicating that the increase of minimum wage is helpful to stimulate enterprise innovation. Then, the minimum wage and enterprise innovation are included in the explanatory variables at the same time, and the regression coefficients are all significantly positive at the level of 1%. However, the coefficient of the minimum wage is lower than that without enterprise innovation. The results indicate that enterprises will tend to increase R&D innovation investment when minimum wage standard rises, which is helpful to promote the process of enterprise digital transformation.

Table 5. Mechanism analysis results

	DTR	R&D Input	R&D Staff	DTR	DTR
Min_wage	0.3102*** (0.0862)	1.0459*** (0.2968)	4.0693*** (0.9344)	0.2992*** (0.0857)	0.3041*** (0.0857)
R&D Input				0.0168*** (0.0030)	
R&D Staff					0.0038*** (0.0010)
Controls	YES	YES	YES	YES	YES
Ind_fixed	YES	YES	YES	YES	YES
Year_fixed	YES	YES	YES	YES	YES
N	21,832	21,832	21,832	21,832	21,832

3.4. Heterogeneity Analysis

The promotion of minimum wage to digital transformation may have different effects in different enterprises. We analyze the heterogeneity according to enterprise property rights, technological attributes and the economic development level of the region where the enterprise is located.

Heterogeneity caused by enterprise property rights. New institutional economics holds that the nature of property rights determines the resource allocation efficiency. There are some problems in state-owned enterprises, such as unclear definition of property rights and implicit guarantee provided by the government, and state-owned enterprises also undertake many non-market functions. In addition, leaders in state-owned enterprises shoulder political attribute and pay more attention to their own promotion prospects, and may not be keen on cultivating enterprise long-term competitive advantages through digital transformation. The above factors will inhibit digital transformation of state-owned enterprises. On the contrary, private, foreign-owned and other non-state-owned enterprises have clear property rights, and are facing more intense market competition. Therefore, they will more actively carry out digital transformation to gain competitive advantage. In this paper, sample enterprises are classified according to the property rights. If they belong to state-owned enterprises, Soe is assigned to 1, while non-state-owned enterprises are assigned to 0. The results of grouping regression are shown in column (1) of Table 6. The regression coefficient in state-owned enterprise group is 0.1068 and not significant, but the coefficient in non-state-owned enterprise group is as high as 0.4590 and significant at 1% level. It shows that facing the pressure of minimum wage, non-state-owned enterprises will take the initiative to carry out digital transformation, but the state-owned enterprises have insufficient motivation for digital transformation and the progress lags behind.

Heterogeneity caused by enterprise technological attributes. The influence of minimum wage on the digital transformation may also be different due to enterprises technology attributes. Subjectively, high-tech enterprises rely more on scientific and technological innovation to maintain their operations, with rapid product upgrading. On the objective level, the digital transformation itself also needs strong scientific and technological strength as its support. On the contrary, non-high-tech enterprises do not rely on technological innovation to maintain their competitive advantage, nor do they have enough technical reserves, so their motivation and ability of digital transformation are weak. Therefore, the promotion of minimum wage to the digital transformation of high-tech enterprises may be more significant. According to whether the industry belongs to high-tech industry, the whole sample is divided into two groups. The grouping regression results are shown in Table 6, column (2). The regression coefficient of high-tech enterprise group reaches 0.3076, which is significantly positive at 1% level, while the coefficient of non-high-tech enterprises is 0.0871 and not significant. It shows that minimum wage has a more obvious role in promoting the digital transformation in high-tech enterprises, but it does not have a significant impact on non-high-tech enterprises.

Heterogeneity caused by region economic development. The location characteristics of enterprises may also affect enterprise digital transformation. The more economically developed areas are usually areas with intensive high-tech enterprises and sufficient technology and talents. And local enterprises can not only enjoy the broad local market and sufficient financial resources, but also enjoy the benefit brought by technology and knowledge spillover. The eastern China is located at the opening-up frontier, where economic development level leads the whole country, and scientific research institutions and technological enterprises are concentrated. So, it is more likely to be in the leading position in the tide of digital transformation. On the contrary, enterprises in the central and western regions may be followers in the digital transformation. In this paper, the whole sample is divided according to whether the companies registered place is located in the east of China, and the grouping regression results are shown in Table 6, column (3). The regression coefficient of enterprise groups in eastern China is significantly positive at the level of 5%, while it is not significant in the central and western regions. It shows that facing the pressure of minimum wage increasing, enterprises in eastern China will more actively carry out digital transformation, while enterprises in central and western China are constrained by location and do not have the conditions and motivation for digital transformation.

Table 6. Heterogeneity analysis results

	(1)		(2)		(3)	
	Soe=1	Soe=0	High-Tec=1	High-Tec=0	East=1	East=0
Min_wage	0.1068 (0.1160)	0.4590*** (0.1009)	0.3076*** (0.1058)	0.0871 (0.1056)	0.2260** (0.1139)	0.1584 (0.1329)
Controls	YES	YES	YES	YES	YES	YES
Ind_fixed	YES	YES	YES	YES	YES	YES
Year_fixed	YES	YES	YES	YES	YES	YES
N	11,183	17,150	14,788	13,545	19,530	8,803

4. Discussion and Conclusions

Nowadays, the digital technology revolution has caused a new tide of industrial transformation, and digital transformation has become a necessary path for the development of modern enterprises. From the perspective of minimum wage, this paper discusses the economic impact of rising minimum wage on enterprise digital transformation. Based on the data of China listed companies and minimum wage, it is found that: (1) The rising minimum wage has promoted enterprise digital transformation, and this basic conclusion still holds robust after changing the estimation method, replacing the explained variables, excluding the financial crisis year and other robustness tests. We also use instrumental variable method to alleviate endogenous problems, and the results keep established. (2) The mechanism analysis shows that enterprises will actively increase R&D and innovation investment to cope with the pressure brought by the rising minimum wage, and then promote the digital transformation process. (3) The promotion of minimum wage to enterprise digital transformation may have different influences among different enterprises and different regions, which shows that in non-state-owned enterprises, high-tech enterprises and enterprises in eastern China, the promotion effect is more significant.

In the digital economy era, we need to re-examine the validity of minimum wage standard and the characteristics of enterprise transformation. Based on the conclusion, this paper puts forward the following suggestions. First, we should pay more attention to the assistance and guidance of enterprise digital transformation. The minimum wage has a positive role in promoting enterprise digital transformation. However, for state-owned enterprises, non-high-tech enterprises and enterprises in economic backward areas, this role is not significant. Therefore, it is necessary to strengthen technical assistance and guidance for the above-mentioned enterprises, establish and improve the market trading mechanism of digital technology, and urge them to actively integrate into the market competition and transformation in the digital economy era. Second, as a non-market pricing mechanism, the motive of setting up the minimum wage is to ensure the low-income people to maintain their basic livelihood and prevent the social income gap from being too wide. However, the rise of minimum wage has accelerated enterprise digital transformation, which may replace low-skilled labor. So, we should pay attention to the unemployment problem caused by this. It is necessary to further improve the system design of minimum wage and the protection policy for workers, and at the same time prevent enterprises from abusing digital technology.

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Conflict of interest: none

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Four-Parameter Lognormal Curves Combined with the Quantile Method of Parameter Estimation as Models of Salary Distribution

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Abstract: The purpose of this paper is to present the four-parameter lognormal curves used to construct salary distributions. The beginning of these curves was considered to be the amount of the minimum wage that was valid on January 1 of the previous year. The maximum sample value was considered as the endpoint. The quantile parameter estimation method was used to estimate the remaining two parameters. Salary distribution models were constructed separately for men and women and according to the employee's educational attainment. The results show that women's salary distributions are characterized by higher skewness and kurtosis and at the same time lower level and variability. Similarly, this is valid for the lowest categories of educational attainment, too. As the level of educational attainment increases, both the skewness and the kurtosis of salary distributions decrease with increasing level and variability. The data for this research come from the Czech Statistical Office.

Keywords: four-parameter lognormal curve; quantile parameter estimation method; salary distribution model

JEL Classification: E24; C51; C55

1. Introduction

The importance of the lognormal distribution as a model for sample distributions cannot be disputed. This model has found application in various fields, starting from astronomy, through technology, medicine, economics, and sociology. The characteristic features of the process described by the lognormal model are the gradual action of interdependent factors, the tendency to develop in a geometric sequence and the growth of random variability into systematic variability, i.e. differentiation. In the field of economics, among the many phenomena that the lognormal model allows to interpret are also salaries and wages of employees and household incomes.

The idea that the logarithms of the values of variables from the field of economics have a normal distribution is of older date and is based on the fact that the effects of a large number of different impulses, the result of which is the value of the observed quantity, are proportional to the state of this quantity at the relevant moment.

The main purpose of this paper is to present four-parameter lognormal curves in combination with the quantile method of parameter estimation as models of salary distribution. Salary distribution models were constructed separately for men and women and according to the education attainment, too. The objective is to specify the typical shapes of

salary distribution models of relatively homogeneous groups of employees created in this way and to monitor the development of these shapes over time. The data for this research covered the period 2014–2020 and comes from the Czech Statistical Office.

2. Review to Literature

Four-parameter lognormal curves have historically been used in various fields of science and research. From a historical perspective, already Saving (1965) uses a four-parameter lognormal distribution to model the scale loss and the size distribution of manufacturing establishment. Siano and Metzler (1969) show that the lognormal distribution provides a convenient four-parameter empirical description of the structureless bands of the ultraviolet absorption spectra of hydroxypyridine derivatives. Lambert (1970) examines methods for estimating the parameters of the four-parameter lognormal distribution. Mahmood (1973) finds that the lognormal distribution of particle size is often applicable to particles in nature and in industrial processes. Wingo (1975) presents a procedure for overcoming anomalies in statistical modeling using the maximum likelihood method for theoretical parameter estimates of three-parametric and four-parametric lognormal distributions. Gentry (1978) used a four-parameter lognormal distribution for particle size and a normal distribution for particle charge, and reports applications of the distribution for modeling the optical diameter of asbestos fibers, the bimodal charge distribution of sodium chloride aerosols, and the size distribution of atmospheric aerosol.

From a more modern perspective, based on a probabilistic fatigue damage mechanics system created by combining statistical fatigue analysis and macroscopic damage mechanics, Zeng and Yu (1991) propose a simplified four-parameter lognormal model in the hope of finding applications in engineering. Wagner and Ding (1994) present two three-parameter and one four-parameter lognormal curves in describing the distribution of size of soil aggregates. Regalado and Ritter (2009) investigate soil water repellency, which can be characterized as the delayed infiltration time of a water droplet resting on the soil surface, which is the penetration time of the water droplet or the persistence of repellency. The authors fit a four-parameter lognormal distribution to both common patterns obtained using dynamic factor analysis and then additively combine them in a weighted multiple linear bimodal model. Malama and Kuhlman (2015) extend a three-parameter lognormal model for the unsaturated hydraulic conductivity of moisture retention using a slight modification of Mualem's theory, which is nearly exact for nonclay soils, to a four-parameter lognormal model by truncating the underlying distribution of pore size distribution to a physically permissible minimum and maximum pore radii.

Bílková (2020) deals with the use of four-parameter lognormal distribution in the field of economics for data on Czech employee wages. Wage distribution models were constructed according to the regions of the Czech Republic, and the different shape of these distributions was researched. Bílková (2019) deals with the comparison of the accuracy of parameter estimation of four-parameter lognormal curves with the accuracy of parameter estimation of three-parameter lognormal curves.

3. Methodology

3.1. Four-Parameter Lognormal Distribution

The random variable *X* has a four-parameter lognormal distribution with parameters μ, σ^2, θ and τ, where $-\infty < \mu < \infty, \sigma^2 > 0, -\infty < \theta < \tau < \infty$, if its probability density has the form

$$f(x;\mu,\sigma^2,\theta,\tau) = \frac{(\tau-\theta)}{\sigma\cdot(x-\theta)\cdot(\tau-\theta)\cdot\sqrt{2\pi}}\cdot\exp\left[-\frac{\left(\ln\frac{x-\theta}{\tau-x}-\mu\right)^2}{2\sigma^2}\right], \quad \theta < x < \tau, \qquad (1)$$

$$= 0, \quad else.$$

The probability density function of the four-parameter lognormal distribution can take different shapes depending on the values of the distribution parameters. The distribution can have two modes for a combination of parameter values $\sigma^2 > 2$ and $|\mu| < \sigma^2\cdot\sqrt{(1-2/\sigma^2)} - 2\,tanh^{-1}\sqrt{(1-2/\sigma^2)}$. Figures 1–3 present the different shapes of the probability density of the four-parameter lognormal distribution depending on the parameter values.

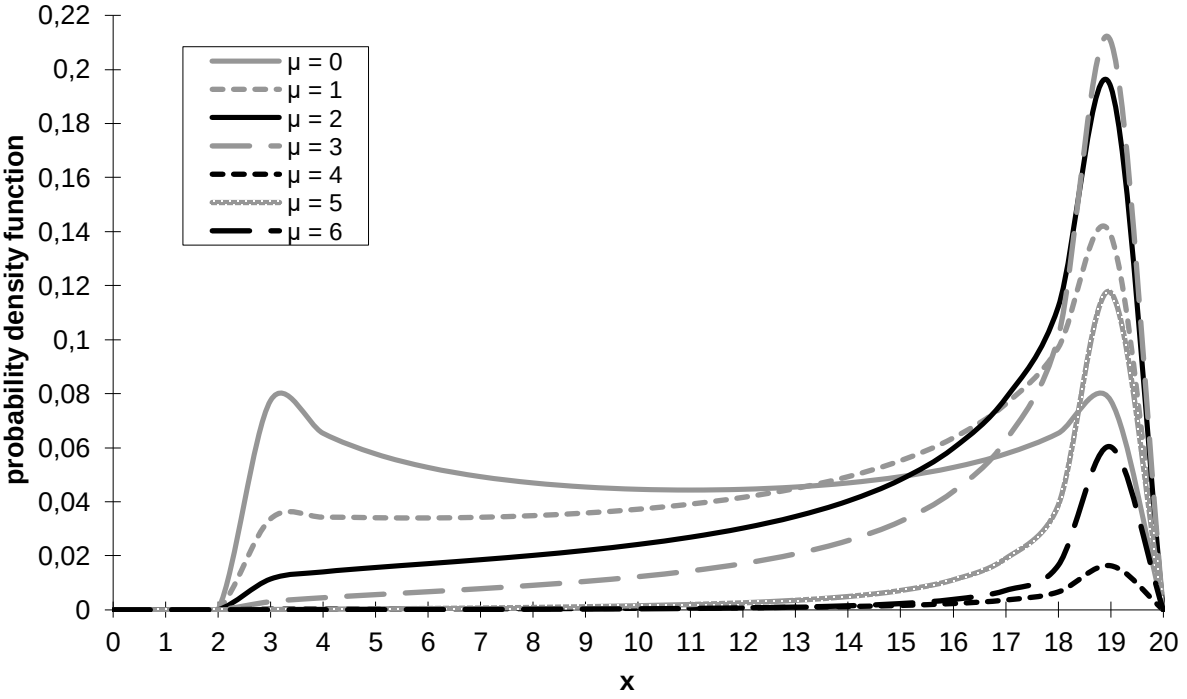

Figure 1. Probability density function shapes of the four-parameter lognormal distribution for parameter values $\sigma = 2$ ($\sigma^2 = 4$); $\theta = 2$; $\tau = 20$

If the random variable *X* has a four-parameter lognormal distribution with parameters μ, σ^2, θ, and τ, then the random variable

$$Y = ln\frac{X-\theta}{\tau-X} \qquad (2)$$

has a normal distribution with parameters μ and σ^2 and is a random variable

$$U = \frac{ln\frac{X-\theta}{\tau-X} - \mu}{\sigma} \tag{3}$$

has a standardized normal distribution.

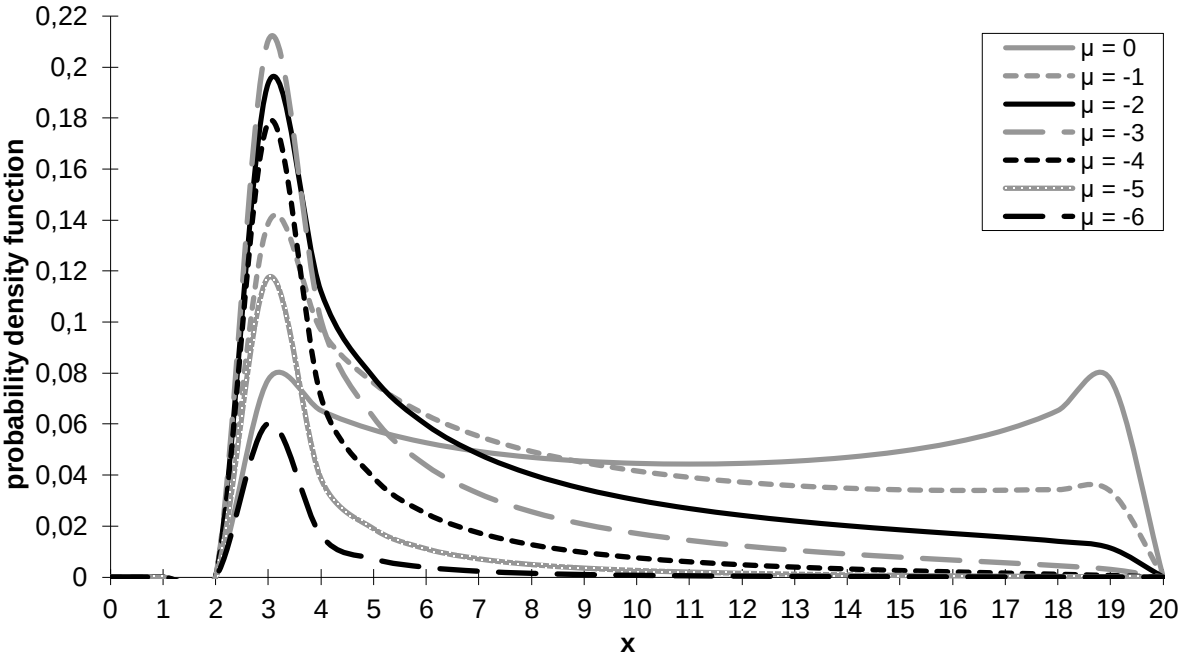

Figure 2. Probability density function shapes of the four-parameter lognormal distribution for parameter values $\sigma = 2$ ($\sigma^2 = 4$); $\theta = 2$; $\tau = 20$

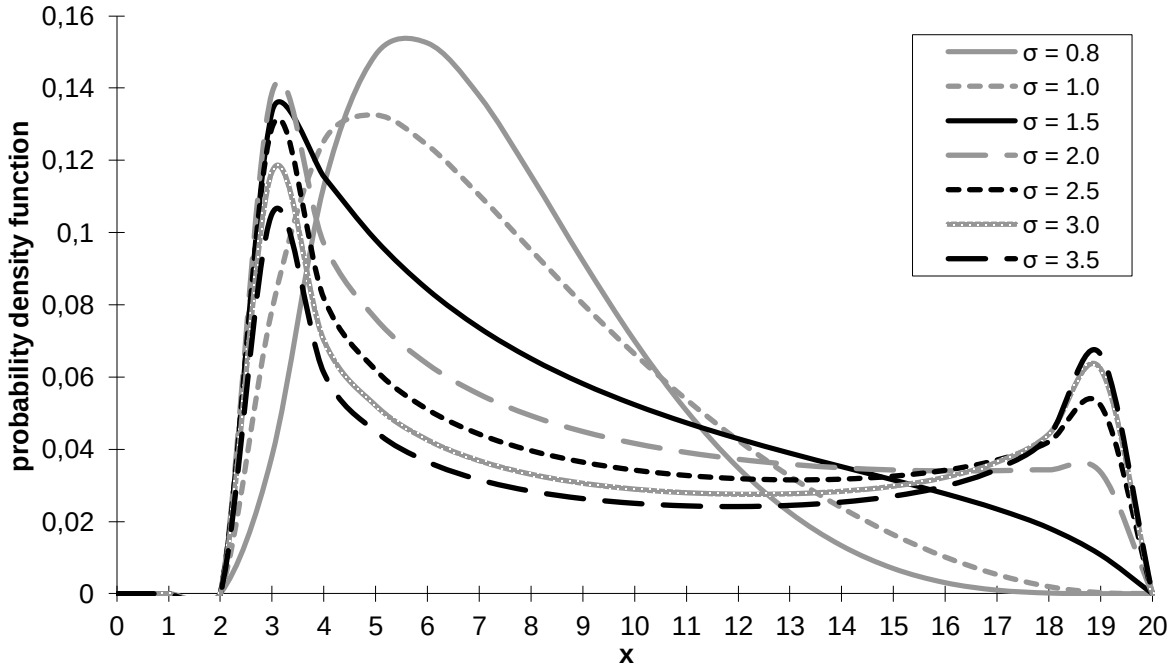

Figure 3. Probability density function shapes of the four-parameter lognormal distribution for parameter values $\mu = -1$; $\theta = 2$; $\tau = 20$

Thus, the parameter μ represents the expected value of the random variable (2) and the parameter σ^2 is the variance of the random variable (2). The parameter θ represents the

beginning (theoretical minimum) and the parameter τ represents the endpoint (theoretical maximum) of the four-parameter lognormal distribution of the random variable *X*. As mentioned above, the random variable (2) has a normal distribution with parameters μ and σ^2. The $100 * P\%$ quantile of the normal distribution with parameters μ and σ^2 of the random variable *Y* has the form

$$y_P = \mu + \sigma\mu_P, \tag{4}$$

where μ_P is the $100 * P\%$ quantile of the standardized normal distribution.

We assume the situation that we know the values of the parameters θ and τ, i.e. we consider the value of the parameter θ to be the monthly amount of the minimum wage valid on January 1 of the previous year (we assume that institutions do not respond quite flexibly to increases in minimum wage amounts, as the data suggests) and the value of the parameter τ to be the maximum sample value. We assume that institutions do not respond quite flexibly to increases in minimum wage amounts, as the data suggests.

3.2. Quantile Method of ParameterEstimation of Four-Parameter Lognormal Distribution for the Case of a Known Theoretical Minimum θ and Known Theoretical Maximum τ

We consider the value of the theoretical minimum θ to be the amount of the monthly minimum wage valid on January 1 of the previous year, and the value of the theoretical maximum to be the highest sample value of the employee's gross monthly salary. We therefore assume that we know the values of the parameters θ and τ and estimate the values of the remaining two parameters μ and σ^2.

We use the random variable (2), which has a normal distribution with parameters μ and σ^2 and the relation (4) for the $100 * P\%$ quantile of this variable. For estimation, we use the sample 50% and 75% quantiles (the sample median and sample upper quartile), which we calculate from the sample data set

$$\tilde{x}_{50} \; a \; \tilde{x}_{75},$$

which we substitute into the equations

$$y_{0.50} = ln\frac{\tilde{x}_{0.50} - \theta}{\tau - \tilde{x}_{0.50}} = \hat{\mu} + \hat{\sigma}\mu_{0.50} = \hat{\mu}, \tag{5}$$

$$y_{0.75} = ln\frac{\tilde{x}_{0.75} - \theta}{\tau - \tilde{x}_{0.75}} = \hat{\mu} + \hat{\sigma}\mu_{0.75} \tag{6}$$

We substitute equation (5) into equation (6) and after adjustment we get

$$\frac{ln\frac{\tilde{x}_{0.75} - \theta}{\tau - \tilde{x}_{0.75}} - \hat{\mu}}{\mu_{0.75}} = \frac{ln\frac{\tilde{x}_{0.75} - \theta}{\tau - \tilde{x}_{0.75}} - ln\frac{\tilde{x}_{0.50} - \theta}{\tau - \tilde{x}_{0.50}}}{\mu_{0.75}} = \hat{\sigma} \tag{7}$$

We estimate the remaining parameters μ and σ^2 using the formulas

$$\hat{\mu} = ln\frac{\tilde{x}_{0.50} - \theta}{\tau - \tilde{x}_{0.50}}, \tag{8}$$

$$\hat{\sigma} = \frac{ln\frac{\tilde{x}_{0.75} - \theta}{\tau - \tilde{x}_{0.75}} - ln\frac{\tilde{x}_{0.50} - \theta}{\tau - \tilde{x}_{0.50}}}{\mu_{0.75}} \quad (9)$$

This theoretical part comes from Bílková (2019).

4. Results

Tables 1 and 2 include parameter estimations of four-parameter lognormal curves for models of salary distribution of men and women and for individual categories of educational attainment. Figures 4–13 characterize the development of models of salary distribution of men and women over time in separation for individual categories of educational attainment.

Table 1. Parameter estimations of the four-parameter lognormal distribution model – men

Year	Educational attainment	Parameter estimation			
		θ	τ	μ	σ
2014	Primary and incomplete	8,000	101,573	–2.118 330	0.592 896
	Secondary without A-level examination	8,000	162,393	–2.469 715	0.453 758
	Secondary with A-level examination	8,000	200,977	–2.204 078	0.352 670
	Post-secondary non-tertiary and bachelor´s	8,000	188,510	–1.967 703	0.405 963
	Higher	8,000	457,977	–2.794 689	0.575 774
2015	Primary and incomplete	8,500	117,100	–2.237 779	0.570 522
	Secondary without A-level examination	8,500	116,202	–2.036 623	0.482 337
	Secondary with A-level examination	8,500	120,376	–1.524 647	0.400 539
	Post-secondary non-tertiary and bachelor´s	8,500	183,333	–1.888 389	0.411 446
	Higher	8,500	468,488	–2.788 649	0.599 332
2016	Primary and incomplete	9,200	125,300	–2.355 467	0.621 345
	Secondary without A-level examination	9,200	123,490	–2.062 272	0.403 059
	Secondary with A-level examination	9,200	140,224	–1.695 371	0.384 522
	Post-secondary non-tertiary and bachelor´s	9,200	188,000	–1.881 127	0.413 765
	Higher	9,200	572,006	–2.927 412	0.564 757
2017	Primary and incomplete	9,900	99,407	–1.964 360	0.687 755
	Secondary without A-level examination	9,900	151,173	–2.196 462	0.399 940
	Secondary with A-level examination	9,900	234,055	–2.209 554	0.359 341
	Post-secondary non-tertiary and bachelor´s	9,900	161,971	–1.589 504	0.445 833
	Higher	9,900	594,331	–2.887 340	0.582 795
2018	Primary and incomplete	11,000	104,681	–1.914 383	0.663 423
	Secondary without A-level examination	11,000	154,303	–2.104 092	0.399 326
	Secondary with A-level examination	11,000	176,811	–1.733 450	0.394 345
	Post-secondary non-tertiary and bachelor´s	11,000	235,085	–1.905 981	0.418 620
	Higher	11,000	656,018	–2.894 681	0.583 026
2019	Primary and incomplete	12,200	159,518	–2.348 750	0.679 378
	Secondary without A-level examination	12,200	99,493	–1.482 924	0.472 031
	Secondary with A-level examination	12,200	244,879	–2.051 387	0.364 590
	Post-secondary non-tertiary and bachelor´s	12,200	174,077	–1.442 107	0.433 196
	Higher	12,200	654,822	–2.830 791	0.556 595
2020	Primary and incomplete	13,350	146,482	–2.118 705	0.726 013
	Secondary without A-level examination	13,350	146,462	–1.888 829	0.457 562
	Secondary with A-level examination	13,350	209,695	–1.804 389	0.382 311
	Post-secondary non-tertiary and bachelor´s	13,350	252,762	–1.824 119	0.411 046
	Higher	13,350	646,957	–2.766 533	0.566 719

Table 2. Parameter estimations of the four-parameter lognormal distribution model – women

Year	Educational attainment	Parameter estimation			
		θ	τ	μ	σ
2014	Primary and incomplete	8,000	90,593	–2.579 553	0.788 679
	Secondary without A-level examination	8,000	70,797	–2.158 153	0.670 754
	Secondary with A-level examination	8,000	137,337	–1.980 799	0.393 808
	Post-secondary non-tertiary and bachelor´s	8,000	114,623	–1.655 765	0.424 112
	Higher	8,000	297,764	–2.587 510	0.398 801
2015	Primary and incomplete	8,500	91,620	–2.580 129	0.841 298
	Secondary without A-level examination	8,500	73,521	–2.190 255	0.726 943
	Secondary with A-level examination	8,500	137,916	–1.963 475	0.420 828
	Post-secondary non-tertiary and bachelor´s	8,500	112,717	–1.603 680	0.461 233
	Higher	8,500	335,055	–2.692 874	0.398 890
2016	Primary and incomplete	9,200	76,701	–2.366 897	0.904 255
	Secondary without A-level examination	9,200	75,881	–2.209 633	0.742 280
	Secondary with A-level examination	9,200	122,007	–1.764 962	0.438 398
	Post-secondary non-tertiary and bachelor´s	9,200	127,865	–1.716 458	0.467 303
	Higher	9,200	318,661	–2.576 965	0.415 020
2017	Primary and incomplete	9,900	80,127	–2.251 009	0.927 585
	Secondary without A-level examination	9,900	86,369	–2.223 049	0.752 519
	Secondary with A-level examination	9,900	203,410	–2.302 699	0.431 193
	Post-secondary non-tertiary and bachelor´s	9,900	151,217	–1.828 363	0.472 733
	Higher	9,900	482,071	–2.946 159	0.413 054
2018	Primary and incomplete	11,000	117,410	–2.565 334	0.921 637
	Secondary without A-level examination	11,000	118,342	–2.443 786	0.739 067
	Secondary with A-level examination	11,000	149,598	–1.831 912	0.457 423
	Post-secondary non-tertiary and bachelor´s	11,000	163,050	–1.806 632	0.481 020
	Higher	11,000	375,665	–2.564 929	0.405 340
2019	Primary and incomplete	12,200	168,069	–2.862 998	0.878 699
	Secondary without A-level examination	12,200	349,411	–3.562 617	0.690 109
	Secondary with A-level examination	12,200	180,463	–1.956 706	0.434 243
	Post-secondary non-tertiary and bachelor´s	12,200	167,464	–1.712 724	0.497 725
	Higher	12,200	404,853	–2.501 197	0.349 863
2020	Primary and incomplete	13,350	158,029	–2.562 577	0.886 544
	Secondary without A-level examination	13,350	159,038	–2.483 049	0.721 258
	Secondary with A-level examination	13,350	240,005	–2.202 998	0.456 740
	Post-secondary non-tertiary and bachelor´s	13,350	240,173	–2.014 099	0.495 540
	Higher	13,350	413,894	–2.419 086	0.317 654

We succeeded to construct models of the salary distribution of Czech employees using four-parameter lognormal curves for the period 2014–2020, separately by gender and educational attainment, while the categories of educational attainment were broken down according to the website of the Czech Statistical Office into five categories: primary and incomplete education, secondary education without A-level examination, secondary education with A-level examination, post-secondary non-tertiary and bachelor´s education and higher education. The models of salary distribution of women are characterized by higher skewness and kurtosis with a lower level and variability compared to the models of salary distribution in the same year and in the corresponding category of educational attainment of men. It was also observed that the models of salary distribution for categories

with the lowest educational attainment have the highest skewness and kurtosis and at the same time the lowest level and variability. As the educational attainment category increases, models of salary distribution tend to decrease in skewness and kurtosis while level and variability increase. For the salary distribution models of men and women for each category of educational attainment, it is true that the models of salary distribution at the beginning of the monitored period are characterized by the highest skewness and kurtosis and at the same time by the lowest level and variability. With the passage of time within the monitored period, the models of salary distribution for men and women and within each category of educational attainment have flattened, their peak also decreases and the level and variability increase.

5. Discussion

While Saving (1965) uses a four-parameter lognormal distribution to model the scale loss and the size distribution of manufacturing establishment, Bílková (2020) deals with application of four-parameter lognormal distribution and quantile method of parameter estimation in modelling of wage distribution, Bílková (2019) again deals with application of four-parameter lognormal distribution and quantile method of parameter estimation and this paper offers some comparison of the accuracy of four-parameter and three-parameter lognormal models. The added value of this paper is the application of four-parameter lognormal curves and the quantile method of estimating the parameters to the salary distribution of employees in the public sphere separated by educational attainment. Different shapes distribution models are typical for individual levels of educational attainment.

6. Conclusions

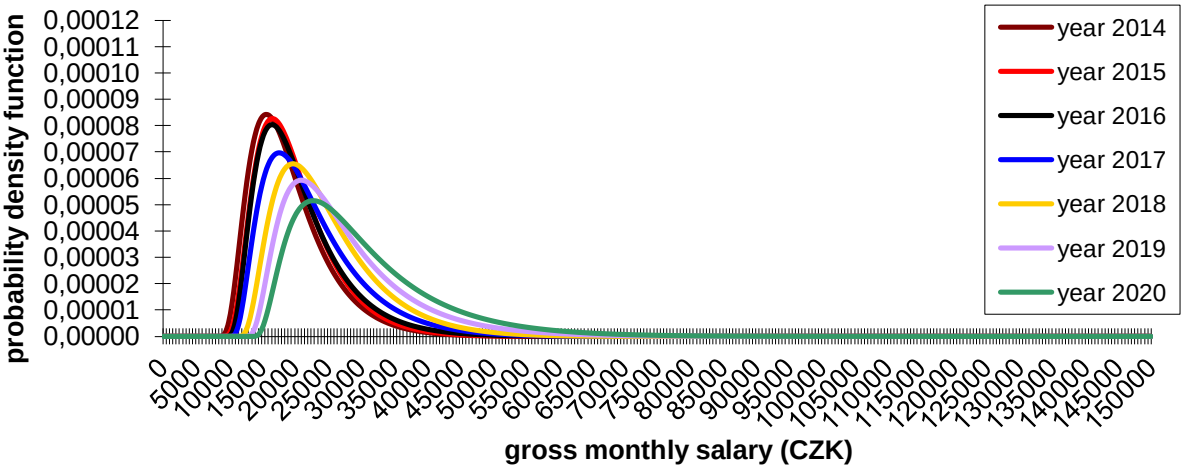

Figure 4. Development of the model distribution of the gross monthly salary of men in the period 2014–2020 for the category primary and incomplete education

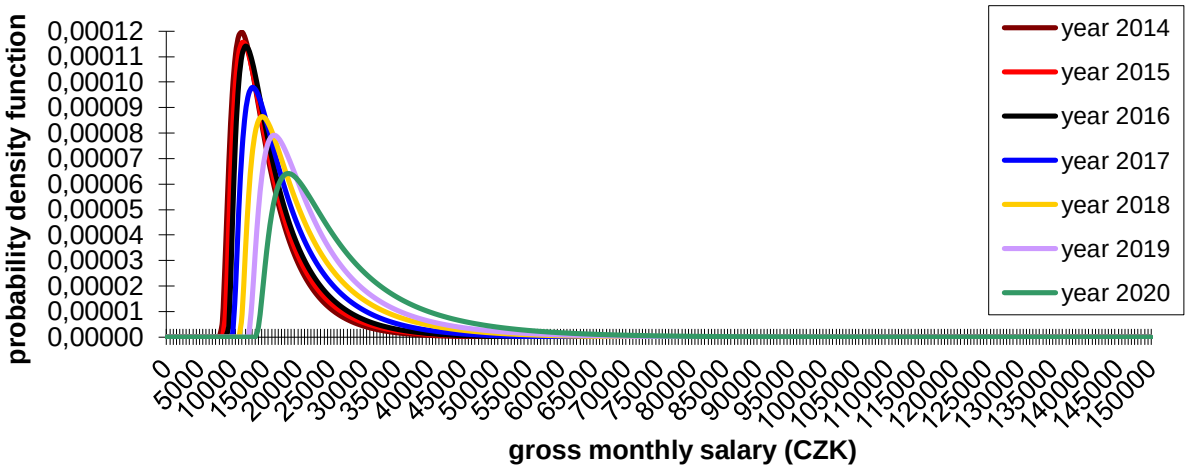

Figure 5. Development of the model distribution of the gross monthly salary of women in the period 2014–2020 for the category primary and incomplete education

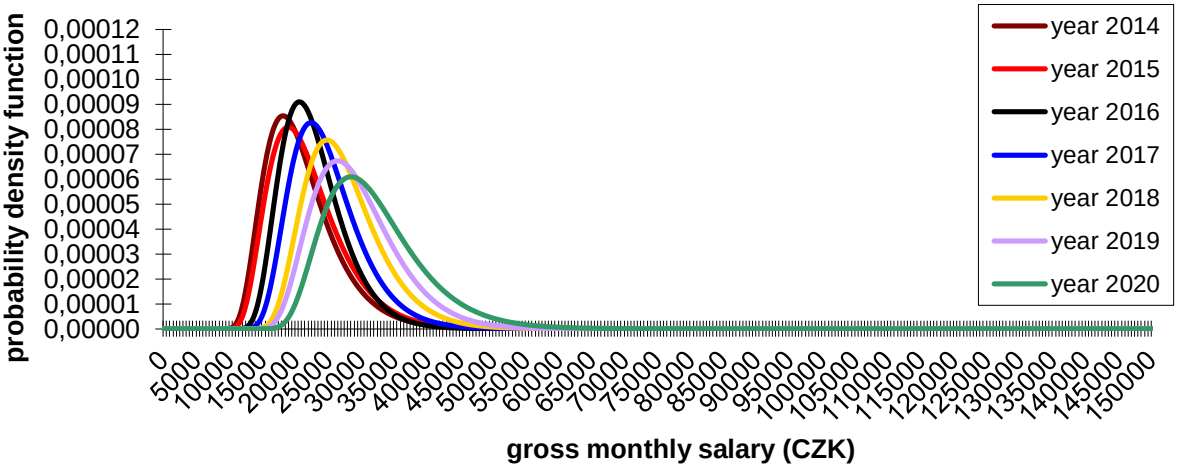

Figure 6. Development of the model distribution of the gross monthly salary of men in the period 2014–2020 for the category secondary education without A-level examination

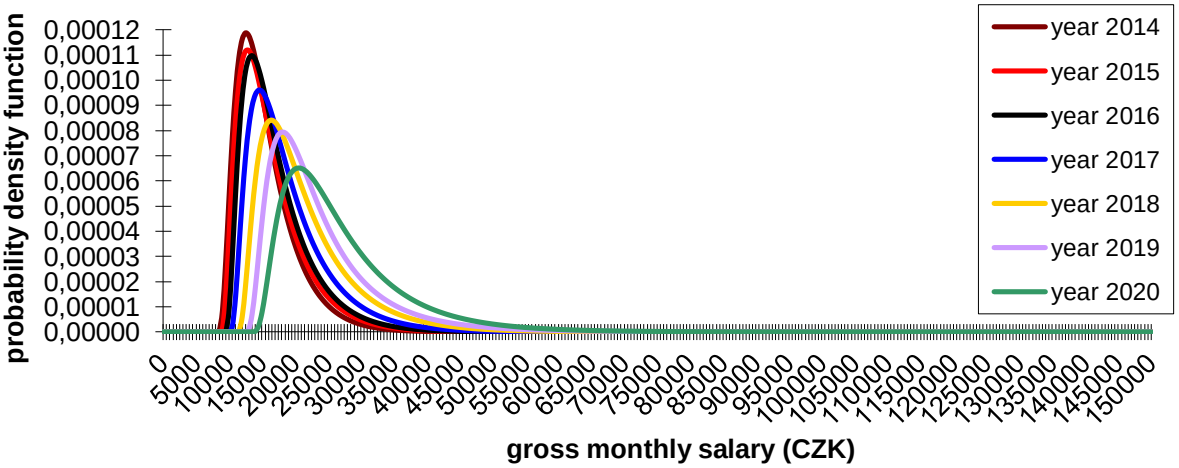

Figure 7. Development of the model distribution of the gross monthly salary of women in the period 2014–2020 for the category secondary education without A-level examination

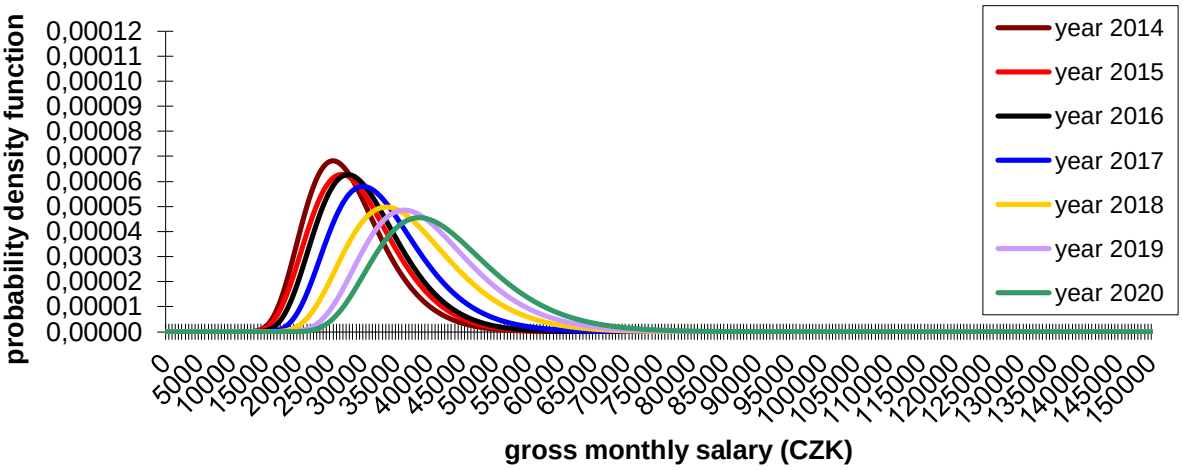

Figure 8. Development of the model distribution of the gross monthly salary of men in the period 2014–2020 for the category secondary education with A-level examination

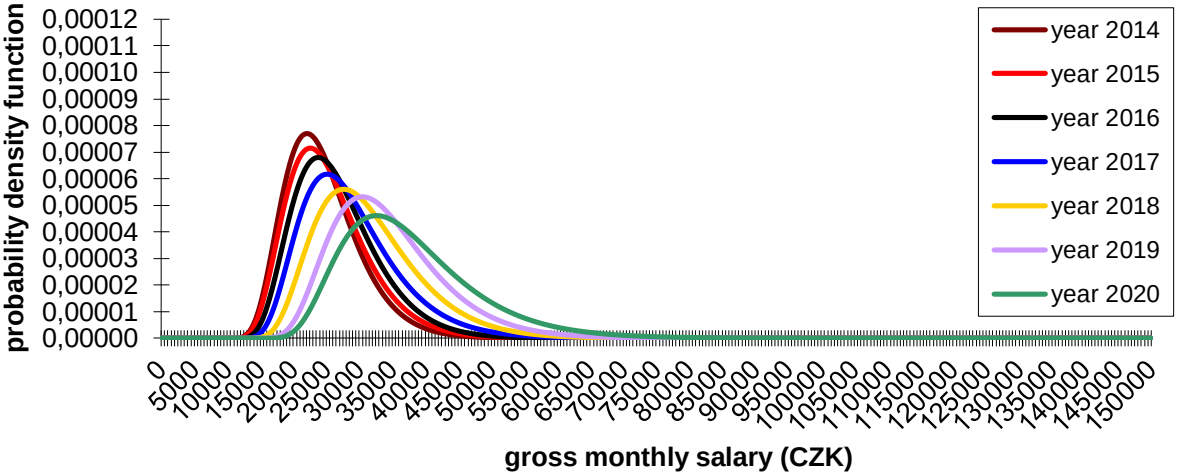

Figure 9. Development of the model distribution of the gross monthly salary of women in the period 2014–2020 for the category secondary education with A-level examination

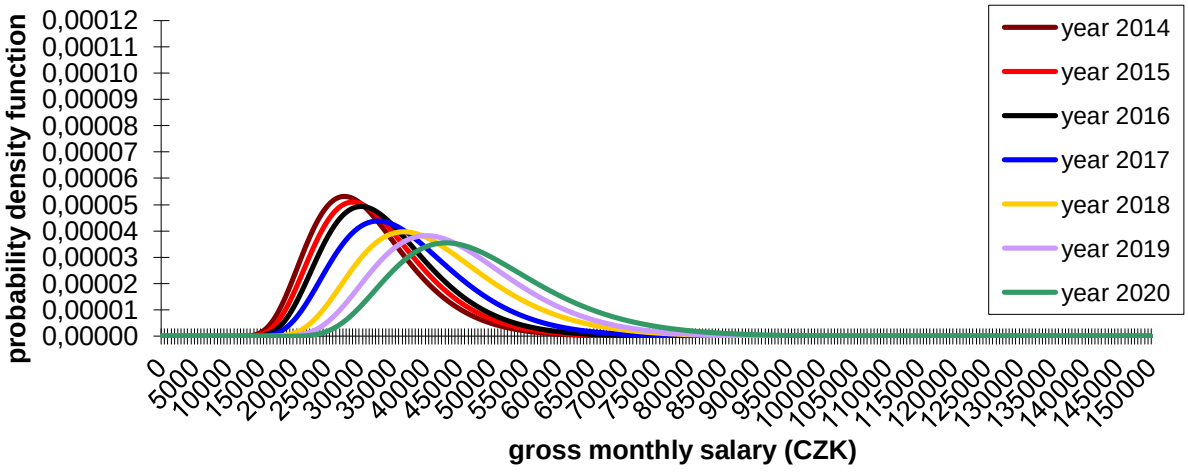

Figure 10. Development of the model distribution of the gross monthly salary of men in the period 2014–2020 for the category post-secondary non-tertiary and bachelor's education

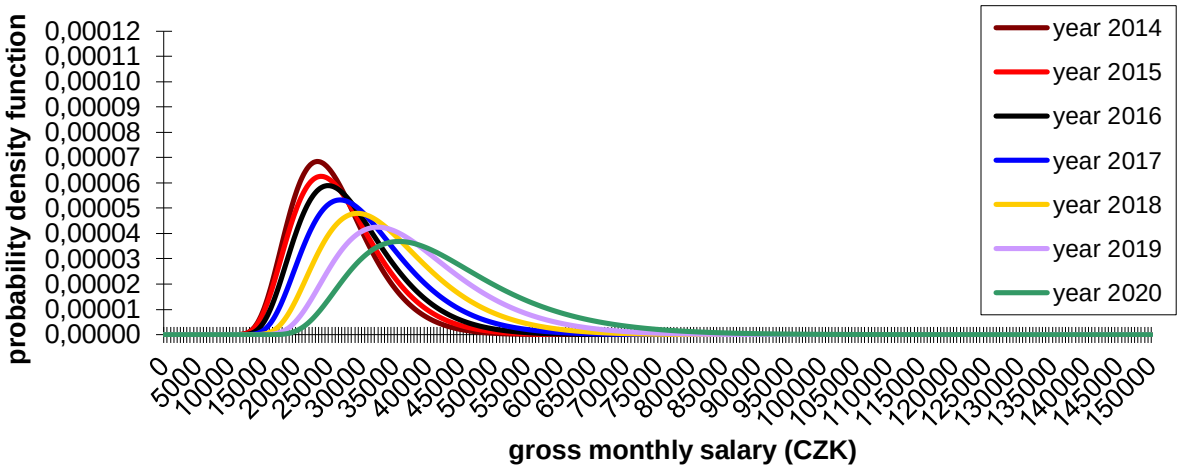

Figure 11. Development of the model distribution of the gross monthly salary of women in the period 2014–2020 for the category post-secondary non-tertiary and bachelor´s education

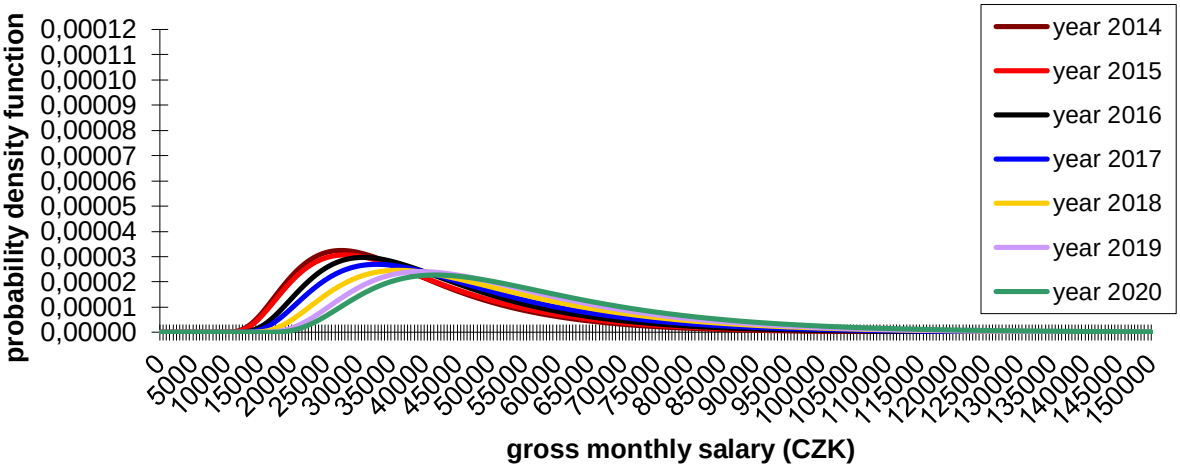

Figure 12. Development of the model distribution of the gross monthly salary of men in the period 2014–2020 for the category higher education

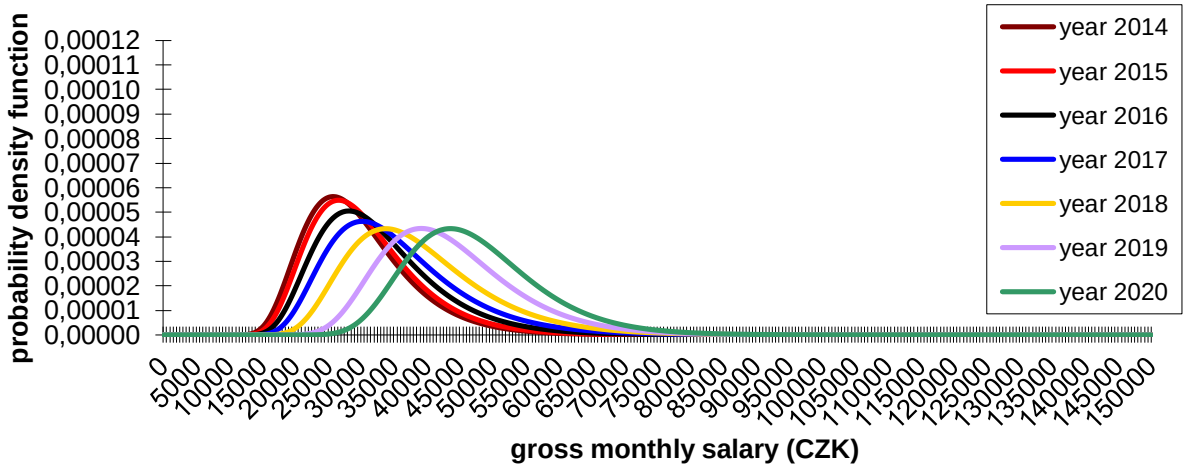

Figure 13. Development of the model distribution of the gross monthly salary of women in the period 2014–2020 for the category higher education

It was possible to construct models of the salary distribution of men and women in the period 2014–2020 according to the individual categories of educational attainment using four-

parameter lognormal curves and quantile method of parameter estimation. It was also possible to identify the specific shapes of model curves of salary distribution for individual categories of educational attainment and capture their development over time. For future research, it will be interesting to compare the results using three-parameter curves.

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Conflict of interest: none.

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Cultural Differences between Czechia and Slovakia in the Light of Global Literacy

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Abstract: National culture and its various dimensions seem to affect various aspects of our lives. However, the role of national culture in the development of global literacy is still unclear. The aim of the paper is to evaluate whether the existence of cultural differences between Slovakia and Czechia can lead to differences in the level of global literacy of university students. The questionnaire-based survey was conducted on a sample of Slovak and Czech university students studying economics and business. The results indicate that despite significant cultural differences between the two nations in terms of some dimensions of Hofstede´s framework, no significant differences in the level of global literacy between both groups of students were detected. It seems that national culture does not play an important role in the development of global literacy and/or the cultural differences between Slovakia and Czechia are not so significant. These considerations deserve further investigation.

Keywords: national culture; dimensions; global literacy

JEL Classification: I23; J16; Z10

1. Introduction

National culture is supposed to affect many aspects of our lives. Literature offers plenty of proves on influences of national culture in such fields as entrepreneurship (Bogatyreva et al., 2019; Laskovaia et al., 2017), informal learning (Kim & McLean, 2014), or strategies for conflict resolution (Le Nguyen et al., 2016). However, little is known about the association between national culture and global knowledge, awareness and the ability to grip global issues, which is also referred to as global literacy (Cakmak et al., 2017). One of the few studies in a similar regard proved some impact of national culture on intercultural competences, however, it appears to be relatively small compared to the influence of organizational culture or gender (Graf, 2004).

The interest of the author is to look in more detail at the level of global literacy of the university students and its determinants. As already suggested by Nair et al. (2012) one of the challenges of promoting students' global literacy lies in developing the capacity of their tacit understanding to connect local and global aspects so that they are useful and meaningful to their lives and work. Previous studies have already showed that there are some factors that help to promote global literacy, such as enrolment in courses related to international business, contacts with foreigners at campuses, gender (e.g. Meng et al., 2017; Karanikola, 2022), communication in foreign languages or the use of social media (Kilinç & Tarman, 2022). Hence,

it is reasonable to assume that national culture could also be an important determining factor in this regard.

When looking at differences in national cultures, Hofstede's (1980) pioneering work on cultural dimensions is among the most attractive. Subsequently, the researchers tried to go beyond the original database by studying other countries that were not included in the pilot work. This was also the case of Slovakia and Czechia, whose cultural differences form the main object-matter of this paper.

One of the important studies in this regard is a work by Kolman et al. (2003) who identified huge cultural differences not only in comparison to Western Europe but also within the group of Central European countries. Specifically, when referring to the original (uncalibrated) scores suitable for comparing these countries, the biggest difference between Slovakia and Czechia (i.e. by 57 points) was detected within masculinity/ femininity dimension, where Slovakia scores extremely towards masculinity. The authors explain this mainly by the fact that, when describing an ideal job, Slovaks do not see much importance in working with people who easily cooperate with each other. The following are the same differences (by 28 points) in the case of power distance and individualism versus collectivism. These differences are mainly explained by various family structures. While in Slovakia extended patriarchal families used to be typical, in Czechia standard families are smaller with a less strong position of the father.

Subsequent studies challenged especially the extreme position of Slovakia with regard to power distance and masculinity, as well as significant differences between Czechia and Slovakia. Bašnáková et al. (2016) showed greater similarities between the Czechs and Slovaks when compared to previous estimates, without reaching extreme values. However, the largest difference between the two nations (by 21 points) still remained in masculinity dimension.

Hence, it is reasonable to expect that existence of cultural differences between Czechia and Slovakia is also reflected in some dimensions of global literacy. The next part of the paper explains methodology applied in the study, followed by the results and their discussion. In addition to a brief summary of the results, the conclusion also provides some implications for future research in this direction.

2. Methodology

Based on the above considerations, the research questions posted in this paper should be as follows:

- Are cultural differences between Slovakia and Czechia underpinned by differences in selected dimensions of global literacy?
- Are there any gender differences in this regard?

Hence, the aim of the study is to evaluate whether the existence of cultural differences between Slovakia and Czechia can lead to differences in the level of global literacy of university students.

First, the cultural differences between Slovakia and Czechia were analyzed. For this purpose, the concept developed by Hofstede et al. (2010) and the scores available at country comparison of Hofstede Insights (2023) were used. Based on this, Slovakia and Czechia score within particular cultural dimensions as follows:

Table 1. Cultural differences between Czechia and Slovakia. (Adopted from Hofstede Insights, 2023.)

Cultural Dimension	Czechia	Slovakia	Difference
Power Distance	57	100	-43
Individualism/ Collectivism	58	52	6
Masculinity/ Femininity	57	100	-43
Uncertainty Avoidance	74	51	23
Long Term Orientation	70	77	-7
Indulgence	29	28	1

The table shows that the biggest cultural differences between Czechia and Slovakia are obvious within power distance dimension as well as masculinity dimension. In both cases Slovakia reports the highest possible scores, thus being a culture with a high power distance and a masculine type of society. The third dimension, which shows higher difference is uncertainty avoidance, which is higher in the case of Czechia. In the case of the rest of cultural dimensions negligible differences are obvious. On the basis of this knowledge, those dimensions of global literacy were subsequently selected, which could be most connected with the cultural dimensions showing the biggest differences. Following dimensions were taken into consideration: risk-taking, relationship development, self-awareness, self-efficacy.

The tendency to take risks is mainly connected with the avoidance of uncertainty, since, as shown by e.g. Çera et al. (2020) highly uncertainty-averse countries tend to be less risk tolerant. With regard to a relationship development dimension within global literacy there is at least partial contentual overlap with masculinity/ femininity and power distance cultural dimensions. For building and maintaining relationships with foreigners it is essential to be open for communication also within domestic environment. Similarly, these two cultural dimensions are also related to self-awareness as critical aspect of global literacy (Nam & Fry, 2010) lying in understanding of own cultural background, its barriers and limitations, needed prior to understanding other cultural profiles. Self-efficacy, often defined as confidence in achieving goals and solving issues, has strong consequences for behavior within organizations, especially from knowledge sharing point of view (Yoon & Han, 2018), similarly as distribution of power within organization and society.

To evaluate students´ level of literacy within these dimensions an online questionnaire-based survey consisting of particular statements was used. Risk-taking attitude was assessed with a general risk-taking question/statement adopted from Dohmen et al. (2017), as well as three complementary statements also focused on the riskiness of purchasing behavior proposed by Donthu and Gilliland (1996). The rest of global competence dimensions were assessed by 21 statements adopted from Arevalo et al. (2012). Survey participants expressed the extent to which they agree with each statement on this 7-point Likert-type scale: 1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = neither agree nor disagree, 5 = somewhat agree, 6 = agree, 7 = strongly agree. Some statements were negatively worded, and therefore the answers to them were subsequently reverse coded. In general, higher scores indicate higher risk-taking tendency and higher level of global literacy in the rest of dimensions.

Survey participants were students studying economics, management and business at two universities, namely: University of Economics in Bratislava, Faculty of Business Economy with seat in Košice, Slovakia (150 students) and Masaryk University in Brno, Faculty of Economics and Administration, Czechia (71 students). It is important to note that in the case of both countries, the responses of only those students who in specific cases stated their national culture as Slovak or Czech were included in the research. Hence, for example, in the case of Czech sample a significant portion of Slovak students studying in Czechia was excluded from the research. Thus, the final number of responses included in this research was 134 Slovak and 49 Czech students. In terms of gender, the research sample consisted of 114 women and 69 men. The students filled out the questionnaire in the last week of the summer term of the academic year 2021/2022 immediately after the particular course under the supervision of the teacher. Hence, all the students participating at the particular course filled out the questionnaire. The significance of differences in the mean scores of responses to individual statements within particular dimensions of global literacy were subsequently tested via a two-sample t-test. The MS Excel Data Analysis tool package was used for data processing.

3. Results

First, the differences in the selected dimensions of global literacy between Czechia and Slovakia have been analyzed. Besides this, table 2 reports also gender differences of the whole sample. When reporting the differences in the mean score, the results of statistical testing of the significance of the differences at the 5% level are also reported.

Table 2. Differences in the level of global literacy between Czechia and Slovakia and in terms of gender

	Culture			Gender – whole sample		
Dimension	Slovakia mean *variance*	Czechia mean *variance*	Difference *p-value*	Women mean *variance*	Men mean *variance*	difference *p-value*
Risk-taking	3.4235 *1.1863*	3.5306 *1.1345*	-0.1071 *0.2771*	3.4122 *1.0542*	3.5181 *1.3682*	-0.1058 *0.2612*
Relationship Development	5.1169 *0.5940*	5.2449 *0.6008*	-0.1280 *0.1610*	5.1740 *0.5410*	5.1135 *0.6932*	0.0605 *0.3045*
Self-awareness	5.0566 *0.4438*	5.2566 *0.4141*	-0.2000* *0.0356*	5.1617 *0.4279*	5.0248 *0.4586*	0.1368 *0.0888*
Self-efficacy	4.7603 *1.2958*	5.0536 *0.9688*	-0.2933 *0.0559*	4.8432 *1.2602*	4.8315 *1.1695*	0.0117 *0.4725*

* Asterisk indicates statistically significant differences at the 95% confidence level.

The results indicate that Czech students show slightly higher level of global literacy as their Slovak counterparts, however the difference is statistically significant only in the case of self-awareness. Higher global competence of Czech students in all dimensions can be attributed to more internationally oriented environment in which they operate. Czech students seem to be more exposed to multiculturalism due to higher portion of foreign students studying at Czech universities. This can partially explain also the significant difference in self-awareness that is connected with recognition and respect for diversity.

When looking at gender differences within the whole sample, women tend to be slightly more risk-averse compared to men. On the other hand, women perform slightly better in development of relationships, as well as in self-awareness and self-efficacy. However, none of these differences are statistically significant. Considering huge cultural differences between Slovakia and Czechia in masculinity dimension it can be expected that a more detailed look at both countries separately in terms of gender may yield distinct results. Hence, further gender related differences were tested. In the case of Slovakia, the total of 91 women and the total of 43 men were in the research sample. In the case of Czechia, research sample consisted of 23 women and 26 men. Table 3 shows results of this gender analysis.

Table 3. Gender differences in the level of global literacy in Czechia and Slovakia

	Slovakia			Czechia		
Dimension	Women mean *variance*	Men mean *variance*	difference *p-value*	Women mean *variance*	Men mean *variance*	difference *p-value*
Risk-taking	3.3956 *1.0931*	3.4826 *1.4089*	-0.0870 *0.3339*	3.4783 *0.9370*	3.5769 *1.3488*	-0.0987 *0.3750*
Relationship Development	5.1227 *0.5419*	5.1047 *0.7196*	0.0181 *0.4499*	5.3768 *0.5081*	5.1282 *0.6762*	0.2486 *0.1335*
Self-Awareness	5.1020 *0.4233*	4.9601 *0.4843*	0.1419 *0.1256*	5.3975 *0.3932*	5.1319 *0.4146*	0.2656 *0.0756*
Self-Efficacy	4.7445 *1.3288*	4.7936 *1.2544*	-0.0491 *0.4084*	5.2337 *0.8371*	4.8942 *1.0671*	0.3395 *0.1160*

In the case of both countries are men slightly less risk-averse than women. Similar results for both countries are shown for the dimension of relationship development and self-awareness with slightly higher scores for women, while this difference is more obvious in the case of Czechia. On the other hand, opposite differences in terms of gender are found in self-efficacy dimension, which may be related to the fact that Slovak women grew up in a markedly masculine society. However, none of these differences are statistically significant.

4. Discussion

Despite obvious difference in the uncertainty avoidance between Slovakia and Czechia, no significant difference was found in terms of risk-taking tendency. It can be explained by the composition of the research sample, since in the case of this study it was not an entire population but a sample of young people who tend to be more risk tolerant. Aversion to risk has a growing tendency during the course of life (proved e.g. by Dohmen et al., 2017), while this growth can be non-linear in individual countries, resulting in greater differences between individual cultures, which, however, should be subjected to further investigation. With regard to gender it is not possible to confirm the prevailing findings resulting from empirical literature (e.g. Charness & Gneezy, 2012; Twumasi Baffour et al., 2019) that men tend to tolerate risk better than women. The insignificance of our results with respect to gender differences suggests rather the existence of publication bias related to gender differences, as already pointed out by Croson and Gneezy (2009).

As for the other dimensions of global literacy, statistically significant differences from a cultural point of view were found only in self-awareness, which is significantly higher in the case of Czech students. Atwater et al. (2009) also pointed out in their study that self-awareness is related to some cultural characteristics, including power distance. Graf (2004) also found some influence of national culture on intercultural competences, however, it appeared to be rather small. Hence, an ability to be globally literate in today's interconnected world does not seem to be primarily a matter of national culture. This ability, or at least some of its dimensions, can be most probably well teachable via classroom-based courses (as pointed out by e.g. Arevalo et al., 2012) or outside classroom via other extra-curricular activities (as show by e.g. Meng et al., 2017).

Regarding the cultural differences between Slovakia and Czechia itself it should be noted that, when compared to the previous work by Kolman et al. (2003), current scores indicate smaller differences. It is obvious especially in the case of masculinity/ femininity dimension within which the original difference of 57 points is currently at the level of 43 points. Since our sample consisted exclusively of university students, i.e. young people, this difference can be expected to be even smaller, thus explaining no significant gender gaps within both cultures. Overall, the cultural differences between Slovakia and Czechia seem not to be so significant and possibly should be subject to revision within future research. There are also other studies that challenge some of Hofstede's original findings. For example, Eringa et al. (2015) showed significant differences in the majority dimensions explained either by relatively small samples or little stability of cultures.

5. Conclusions

The paper was focused on evaluation of cultural differences between Slovakia and Czechia and their association with selected dimensions of global literacy. The research sample consisted of university students approximately the same age as the representatives of the respective culture. The results show that cultural differences between Slovakia and Czechia are still strong in some dimensions of Hofstede´s framework, but seem to be diminishing over time. Despite these cultural differences between the two nations, no significant differences were found in the level of global literacy between the two groups of students, except for self-awareness. Hence, cultural differences between Slovakia and Czechia shown within Hofstede Insights (2023) seem not to be underpinned by differences in selected dimensions of global literacy.

Insignificance of the findings with regard to majority of investigated global literacy dimensions can basically be explained by two considerations. First, the nature of national culture does not appear to affect development of literacy related to global environment and foreignness markedly, since this is rather teachable competence. Second, the evaluation of cultural dimensions of Slovakia and Czechia should be revised, since cultural differences between these countries seem not to be so huge in some dimensions, especially masculinity/ femininity and uncertainty avoidance.

In terms of gender, no statistically significant differences were detected in any of the analyzed dimensions. This is true both for the entire sample as well as when looking at the

national subsamples separately. There is not a significant gender gap neither in the case of Slovakia nor in Czechia, which also do not support the generally declared high difference between the two nations in the masculinity/ femininity cultural dimensions. A more detailed investigation of these connections represents an interesting future research ambition.

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Conflict of interest: none.

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Sectoral Productivity – FDI Allocation Nexus in Bulgaria after the 2008 Global Crisis

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Abstract: Foreign direct investment (FDI) influx in Bulgarian economy has been studied comprehensively since the start of market transition in early 1990s. FDI were expected to be a major driver of the resurrection and restructuring of Bulgarian post-communist economy. Fifteen years after obtaining full EU membership of Bulgaria, this topic continues to receive an extraordinary degree of interests by economists especially in the enhancing processes of business globalization during the last decade. The major aim of this study is to suggest some preliminary results of an empirical analysis of the links between sectoral labor productivity and the intensity of foreign direct investment allocated to various sectors of Bulgarian economy. For this purpose, several specifications of an econometric model are estimated by panel data for the period 2008-2021. Annual data is used for the economic sectors defined in the framework of the International Standard Industrial Classification of economic activities (ISIC-2008). Statistically significant results are obtained for various effects of the sectoral allocation of FDI in the Bulgarian economy on the level of sectoral labor productivity.

Keywords: foreign direct investment; sectoral allocation; sectoral dynamics; Bulgaria

JEL Classification: O40; F21

1. Introduction

Research interest on FDI inflows and operation issues in Bulgaria date back to the 1990s – a decade frequently called "early transition period" – when such investments were exceptionally needed for the goals of economic resurrection and restructuring of Bulgarian post-communist economy. Such expectations were kept at a high level during a period of active economic development induced of the EU accession process (2001-2006) when a significant FDI influx has been observed. Currently, over thirty years after the start of economic reforms and market transition the interest in this topic did not weaken especially in conditions of enhancing globalization of the European economy where the Bulgarian one needs to integrate.

An overview of FDI influx in Bulgaria during the middle of that decade showed no substantial interest by strategic foreign investors unlike the one observed in Central European countries (Koparanova, 1998). Using firm-level panel data Konings (2001) investigates FDI effects on productivity performance of domestic firms in Bulgaria, Romania and Poland as CEE transition economies applying GMM techniques. Taking into account any potential endogeneity of the ownership, this analysis found no evidence of positive spillovers to domestic firms but indications for negative ones in Bulgaria and Romania. The author infers for "a negative competition effect that dominates a positive technology effect" (Konings, 2001).

At the end of the 1990s an increase of FDI inflows was observed, especially by EU based international companies, that were oriented mainly towards industry, financial sector, and to some extent the trade. Using panel data for 11 manufacturing sectors for 1998-2001 about the distribution of FDI in Bulgarian manufacturing sectors, Mintchev et al (2002) provide evidence that resource-intensity based motivation is a factor of increased foreign investments in manufacturing sectors, irrespective of the branch size. Moreover, the export potential of these sectors was identified as a stimulus for EU investors' interest in Bulgarian industry. Further advancing to the period of EU accession, an analysis of the spatial variation of GDP per capita in Bulgaria for the period 1999-2005 provides empirical evidence for a significant positive net effect of the spatial concentration of FDI on the regional income level (Boshnakov, 2008).

Radulescu et al. (2016) have studied the influence of political and economic institutional factors as well as the quality of labor force on the level of foreign direct investments in Bulgaria and Romania. Noting that the two countries succeeded to attract large amounts of FDI only for a short period of time during the mid-2000s (displaying a very friendly investment climate, e.g. low corporate tax rates), the analysis – utilizing yearly data for 16 years (1999-2014) – reveals that other circumstances hindered the sustainable interest of foreign investors, like political and fiscal instability, low quality of the infrastructure, weak governance and corruption spreads (Radulescu et al., 2016). Using nonlinear autoregressive distributed lag models with annual data for the period 2000-2018 Kurtovic et al. (2021) found evidence for an asymmetric impact of FDI stock on the mean wage levels in Bulgaria and Slovenia. Ultimately, this analysis leads to the conclusion that the growth of net average wages in South East European countries, as a result of enhancing the economy competitiveness and increasing productivity, "depends on policies and measures to attract FDI".

Vuckovic et al. (2020) explore the linkages between business environment and inward FDI for a sample of 5 European emerging economies: Poland, Slovenia, Bulgaria, Romania and Serbia. Implementing regression models the authors identified significant linkages between FDI inflows and some "Ease of Doing Business" indicators, controlling for macroeconomic performance, business regulations, taxation, and market capitalisation. Popescu and Brostescu (2022) studied the dynamics of FDI stock in Bulgaria and Romania in the period 1995-2018 when econometric evidence provides explanation for some determinants of FDI growth in these countries. Particularly for Bulgaria such determinants were found to be the increase in exports, trade balance and balance of payments. Additionally, higher levels of country economic freedom score (indicating enhanced freedom of the business environment), lower levels of taxation, and limited corruption practices were found to increase FDI inputs in Bulgarian economy.

The paper suggests some preliminary results of an econometric analysis of the level of labor productivity of the main economic sectors as a function of the sector allocation of FDI in Bulgarian economy. It is generally considered that the influx of FDI into a host economy contributes considerably to its development through a range of positive effects (e.g. technological renewal, know-how transfer, export facilitation, and other positive spillover effects) but could also induce some negative externalities as well. The analysis here covers the period since the start of the global crisis in 2008 till the global pandemic crisis of 2020-2021.

2. Data and Methodology

The econometric models in the current study are estimated using official data for the main economic sectors as provided by the Bulgarian National Statistical Institute (NSI) for the period 2008-2021 (data for 2021 are preliminary and subject to revision). After a medium-term period of accelerated growth during the EU accession (2001-2007) the FDI stock reached a level of about 20 bn EUR during the crisis of 2008-2009. This growth continued during the post-crisis revival so at the end of the second decade FDI stock level in Bulgaria reached 28 Bn EUR (about 40% of the GDP for 2021).

Data for the economic sectors are provided by Bulgarian NSI following the international standard according to the Classification of Economic Activities (CEA-2008), particularly in the framework of the so called "Structural Business Statistics" (NSI, 2022a; 2022b).

- B Mining and quarrying
- C Manufacturing
- D Electricity, gas, steam and air conditioning supply
- E Water supply; sewerage, waste management and remediation activities
- F Construction
- G Wholesale and retail trade; repair of motor vehicles and motorcycles
- H Transportation and storage
- I Accommodation and food service activities
- J Information and communication
- L Real estate activities
- M Professional, scientific and technical activities
- N Administrative and support service activities

(Sector K "Financial services" is omitted due to data limitations).

The data used for the analysis comprises of a panel of N=12 sectors with T=14 annual observations per each variable for each sector which provides a pool of 168 observations. However, when a lagged variable is entered as a predictor, the length of the time series shrinks to 13 so the panel data pool is restricted to 154 observations.

A linear specification of the multivariate regression model was used in the form:

$$Y_{i,t} = c_0 + c_1 X_{1i,t} + c_2 X_{2i,t} + c_3 X_{3i,t} + e_{i,t} \quad (1)$$

where: c_j are the coefficients (model parameters) to be estimated (j = 0, …, k); $Y_{i,t}$ is the dependent variable; $X_{j,i,t}$ are the independent variables (j = 1, …, k); $e_{i,t}$ is the disturbance term. However, due to the panel nature of the data this term is assumed to be a "composite error" variable that has the following structure: $e_{i,t} = a_i + b_t + u_{i,t}$, where a_i (I = 1, …, s) is an unobserved sector effect (time-constant sector-specific component), b_t (t = 1,… ,T) is an unobserved time effect (annual time intercept), and $u_{i,t}$ is an idiosyncratic error.

In order to check for a nonlinearity, double-log specification was also used in the form:

$$Ln(Y_{i,t}) = d_0 + d_1 Ln(X_{1i,t}) + d_2 Ln(X_{2i,t}) + d_3 Ln(X_{3i,t}) + e_{i,t} \quad (2)$$

In order to capture any eventual trend effects in the dynamics of the variables, time dummy variables have been introduced in the model. Since the sectors chosen cannot be considered as a random sample a fixed-effects panel regression model has been estimated involving sector dummy variables as well. This way, the model estimates have been obtained by the "least squares dummy variables" (LSDV) method. Here we cannot assume the independent variables to be uncorrelated with the unobserved sector-specific effect, so the chosen estimation method is recommendable in such a case. Moreover, in the current study the panel used is not only short (fixed T) but also N is small, so most of the diagnostic tests for panel regression are not valid. Also, the properties of the random effects estimator with small N, even if T is large, are generally unknown (Wooldridge, 2013, p. 494).

For the purposes of the current analysis two independent variables have been constructed in order to evaluate the impacts of the FDI allocation on the labor productivity of the economic sectors. They should capture any specifics of the "volume" and "intensity" effects of the FDI accumulation at the various sectors:

X1.1- FDI capital intensity of the sector (measured by the average FDI per one employed in the sector, recalculated from thousand EUR to thousand BGN).

X1.2- relative scale of FDI as compared to the accumulated Fixed Assets (FA) in the sector (measured by the ratio of the accumulated FDI to the FA);

Additional control variables have been introduced

X2- cost efficiency of the sector (measured by the production costs per 100 BGN of revenues in the sector);

X3- scale of the sector (measured by the number of employed in the sector).

The alternatives of the econometric model were estimated using a dependent variable that measures the annual level of labor productivity in the economic sectors:

Y- Annual revenues per employed in the sector (in thousand BGN).

Two hypotheses are tested in the sense that each of these alternative measures of FDI influx into the sectors has particular effect on the level of sectoral productivity.

3. Results

3.1. Estimated Model (1) with Main Regressor: "FDI per Employee"

Table 1 presents the results of the estimated linear specification (1) with all variables (independent and dummy) entered in the model. Very few diagnostic tests have been implemented as far as the dataset does not contain neither long time series ($T = 14$) nor large sample of panel units ($N = 12$).

The results of the partial F-tests show that the choice of fixed effects specification is correct, as much as the estimated LSDV group intercepts a[i] prove to vary significantly. The residuals showed significant serial correlation and heteroscedasticity, so robust (HAC) standard errors have been employed for the t-tests. This model provides evidence for a statistically significant net effect (at 5% level of significance) of the independent variable "FDI-per-employee" *ceteris paribus*, i.e. after isolating the sector- and time-specific effects as well as controlling for sectors scales and cost efficiency level.

Table 1. Estimated model (1), DV: Sectoral revenue per employed; Regressor: FDI per employee

	Coefficient	Std. Error*	t-ratio	p-value
Intercept	169.483	30.0658	5.637	0.0002
X1.1- FDI per employed	0.737	0.256	2.875	0.0151
X2- Cost per 100 of Revenue	−0.648	0.192	−3.366	0.0063
X3- Size (N.Employed)	−6.31e-05	0.00011	−0.571	0.5791

* Robust (HAC) standard errors
Joint test on named regressors – Test statistic: F(16, 11) = 5.586e+12
with p-value = P(F(16, 11) > 5.586e+12) = 1.167e-68
Robust test for differing group intercepts – Null hypothesis: The groups have a common intercept
Test statistic: Welch F(11, 61.1) = 53.1 with p-value = P(F(11, 61.1) > 53.1) = 4.56e-27

3.2. Estimated Model (1) with Main Regressor: "Ratio FDI / Fixed Assets"

Table 2 presents the results of the estimated linear specification with all variables (independent and dummy) entered in the model after replacing the first alternative for FDI intensity by the second one – the ratio of FDI to fixed assets in economic sectors.

Table 2. Estimated model (1), DV: Sectoral revenue per employed; Regressor: Ratio FDI to FA

	Coefficient	Std. Error*	t-ratio	p-value
Intercept	182.342	46.020	3.962	0.0022
X1.2- FDI / Fixed Assets	23.293	9.211	2.529	0.0280
X2- Cost per 100 of Revenue	−0.557	0.260	−2.142	0.0554
X3- Size (N.Empoyed)	−0.000148	0.000144	−1.030	0.3250

* Robust (HAC) standard errors
Joint test on named regressors – Test statistic: F(3, 11) = 13.53
with p-value = P(F(3, 11) > 13.53) = 0.000519847
Robust test for differing group intercepts – Null hypothesis: The groups have a common intercept
Test statistic: Welch F(11, 61.0) = 181.24 with p-value = P(F(11, 61.0) > 181.24) = 3.00e-42

The results obtained using the second alternative for the sectoral FDI intensity confirm those from the first one. Fixed effects specification proves to be an appropriate one (the null hypothesis for a common group intercept is strongly rejected). Implementing robust standard errors again, the model shows a significant net effect of the predictor "Ratio of FDI to Fixed Assets" on the sectoral labor productivity at 5% level of significance, other things equal.

3.3. Estimated Model (2)

Table 3 presents the results of the estimated log-log model, also including sectoral and time dummy variable. Both alternatives for the sectoral FDI intensity are used.

After checking for robustness of the specification, the nonlinear model confirms the statistically significant net effects of the FDI regressor for both of its alternative proxies. The effect of "FDI per employee" is found to be significant even at 1% level.

Table 3. Estimated model (2), DV: Ln(Sectoral revenue per employed)

	Coefficient	t-ratio‡	Coefficient	t-ratio‡
Intercept	6.144	3.896***	6.999	3.351***
Ln(X1.1)- FDI per employee	0.132	3.518***	–	–
Ln(X1.2)- FDI / Fixed Assets	–	–	0.140	2.627**
Ln(X2)- Cost per 100 of Revenue	−0.259	−1.623	−0.167	−0.7986
Ln(X3)- Size (N.Employed)	−0.0689	−0.7485	−0.133	−1.017
** Significant at 5%; *** Significant at 1%; ‡ Based on robust (HAC) standard errors.				

After checking for robustness of the specification, the nonlinear model confirms the statistically significant net effects of the FDI regressor for both of its alternative proxies. The effect of "FDI per employee" is found to be significant even at 1% level.

4. Discussion

After controlling for cost efficiency and scale of the sector, empirical evidence is observed (at acceptable level of significance) for a significant net effect of each alternative predictor of the sectoral labor productivity approximated by the revenue per employee, namely:

1. the FDI capital intensity of economic sectors (measured by the accumulated FDI per one employed in the sector);
2. the relative scale of FDI accumulated in economic sectors compared to the level of sectoral Fixed Assets (measured by the ratio of FDI to the Fixed Assets).

These results confirm a variety of effects of inward FDI on sectoral development identified by different studies – for example, Egger and Pfaffermayr (2001) use a small panel of Austrian manufacturing sectors to implement a CES production function by which evidence is provided for "productivity improving effects of inward FDI. Emako et al. (2022) also find that FDI boosts the sectoral labor productivity in developing countries for the period 1990-2018, however, by facilitating "structural change". Juda and Kudo (2020) utilize unbalanced firm-level panel data for the period 2000-2015 and estimate positive spillover effects of the presence of foreign firms on the labor productivity of local firms in the same industry. However, further investigation of more detailed effects is necessary as far as these authors find negative results for the "backward linkages" of FDI and labor productivity of domestic firms.

5. Conclusions

There is no doubt that the concentration of FDI in particular economic sectors is of certain importance for their stability in the turbulent period of post-2008-crisis and the following development after 2014-2015. As a small open economy Bulgaria is not an isolated case and the observed developments are similar to those at the other Eastern European countries that are new EU member states and need to operate in the common EU market place. Various analyses have been conducted on a range of issues concerning the effects of FDI influx in Bulgarian economy, however, rarely empirical evidence has been provided yet for effects evaluated using data at sectoral level. The current paper attempts to contribute to the

empirical analyses of foreign investment effects in a new EU member state during the second decade of the 21st century. Although such analysis could be performed in a more comprehensive econometric framework, its results – although of preliminary nature – are indicative about the significant interrelation between sectoral labor productivity level and the degree of FDI concentration in Bulgarian economic sectors.

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Conflict of interest: none

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Digital Wellbeing of University Teachers

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Abstract: This paper focuses on identifying selected aspects of digital well-being among university teachers. It aims to determine the level of perceived technostress and threats caused by the digitization of work among a selected group of respondents. The methods used were questionnaire survey and in-depth interviews. Questionnaires were answered by 60 respondents from the Czech Republic and Slovakia, in-depth interviews were conducted with six respondents. The results showed that the respondents consider the use of digital technologies and tools in their work to be important, confirm that they have up-to-date and safe digital tools at their disposal and that using them does not cause them stress. However, the in-depth interviews revealed that certain technostressors are affecting them. Increased digitalization does not make respondents feel isolated or invisible and has not affected the level of communication in their workplace. The results show that the term technostress is not yet widely known among this population and that they are coping with the increase in digitalization quite successfully, although some at the expense of their personal lives.

Keywords: digital wellbeing; technostress; university teachers; Czech Republic; Slovakia

JEL Classification: M12; M54

1. Introduction

The Covid-19 pandemic has caused enormous damage worldwide, but it has also brought something positive. It has initiated or accelerated many changes in the field of work, some of which have become the new norm. In terms of the organizational environment, this is particularly true of remote working. Linked to this is the need for a greater presence of online communication and the use of mobile phones and emails.

A lot of research has been carried out on these aspects, looking at people's ability to cope with change, their satisfaction with it and the quality of support. As the situation returns to normal, employees are returning to companies, but many continue to use hybrid forms of employment and many take the option of working partly from home for granted. Legislation is gradually responding to this, education began to respond to some aspects even before the pandemic (Zatrochová et al, 2018). So far, however, only an amendment to the Labor Code has been prepared in the Czech Republic, which will now require employers to bear the costs of working from home. In the context of occupational health and safety, no modification of the current rules is being considered. Therefore, the conditions for working from home should be the same as for working on the employer's premises, including risk assessment. However, the risks do not yet include technostress and the right of unavailability speaks of normal working hours (Znalostní system prevence rizik v BOZP, 2023).

This paper looks at the psychological aspects caused by the significant increase of digitalization in the work of university teachers. These are technostress and isolationism. It is based on research carried out within the Erasmus+ project DWEL, which aims to develop support materials to improve digital wellbeing in this category of employees.

1.1. Technostres

The term technostress comes from Craig Brood a clinical psychologist who used it first in 1984. It is a modern disease that impacts people they are not able to adapt enough to using informational technologies (Brod, 1984). Research realized by Nisafani et al. (2020) showed that technostress could be a reason for anxiety, exhaustion, decreasing of performance and therefore produces job dissatisfaction. It is broadly accepted that they are five causes of technostress (Tarafdar et al., 2007):

- Techno-overload – the potential of informational technologies (IT) to drive an employee to work faster.
- Techno-invasion – the potential of IT to invade an employee's personal life with possibilities to, for example, perform job tasks.
- Techno-complexity – an inherent quality of IT that makes employees feel incompetent.
- Techno-insecurity – a premise that the nature of IT is to change regularly, and that this may threaten employee job security.
- Techno-uncertainty – constant changes and upgrades of software and hardware may impose stress on employees.

Proactive coping can act as a protective factor for employees facing technostress (Pirkkalainen et al., 2019). Proactive coping refers to the effort an individual puts into building resilience to ongoing stressful situations (Schwarzer & Taubert, 2002). It seems, that they also exist some factors minimizing technostress. They could be higher educational level, higher technology self-efficacy (Ragu-Nathan et al., 2008), and a lower level of technology dependency (Shu et al., 2011 in Nisafany et al., 2020).

1.2. Isolationism

In the US, recent research has found that 37% of jobs can be done entirely from home, but with considerable variation across industries and cities (Dingel & Neiman, 2020). In Canada, an estimated 41% of jobs can be performed from home. There are studies that have shown the negative impact of new workplace models on employees through increased levels of stress and anxiety (Shaw et al., 2020). The COVID-19 pandemic has led to dramatic changes in various aspects related to leadership and management (Bednarikova & Kostalova, 2022). These changes are particularly in the areas of (Mirakyan & Berezka, 2021):

- Communication – indirect, electronically mediated communication is impoverished by some elements of non-verbal communication, often only problem-oriented, and the socializing elements of communication are lost.
- Conflict resolution – online environments make it easier to break contact when there is conflict, not to resolve the conflict and then it escalates.

- Leadership - the leader does not have the opportunity for sensitive informal control (e.g. when passing through the workplace, chance meetings with workers, etc.), communication is limited, problem-oriented, the opportunity to give small informal rewards is limited.
- Virtual teamwork – the technology exists but is not fully fledged; it is harder to ask for help; social support is lacking.
- Stimulation – workers do not have frequent informal feedback, must work more independently, tasks may be more complex with longer deadlines and therefore not enough stimulation from supervisor, lack of collective stimulation.

Many of them foster a sense of isolation among remote workers.

2. Methodology

The main purpose of this paper is to examine the perceived technostress, its coping and some negative aspects of digitalization at work. A questionnaire survey was used to collect data from at least partner countries involved in the project (Czechia, Ireland, Finland, and Slovakia;). The respondents were only from high education institutions. Six project partners – educational institutions used their networks and asked respondents to re-send the link to their partners (a snowball sampling method). We believed that no one would fill out the questionnaire a second time, but it is possible that someone may forget to fill it out and a request from another sender will make them fill it out. The questionnaire was created in English, put on website and the link for it was sent. For Czech respondents the questionnaire was translated to Czech and respondents received link for it. We took advantage of the similarity of Slovak and Czech languages and the interconnectedness of Czech and Slovak university teachers and the link to the Czech version of the questionnaires was also sent to some Slovak universities. The survey began on 1st June 2022 and finished on 30th June 2022.

The survey included demographic questions, focused only on gender, respondent´s position in organization and country. A question on the respondent's position in the organization with multiple choice answers – Head of department, HEI manager, Lecturer, Researches, another - was inserted to reveal whether the questionnaire was completed by a respondent outside the target group. The next group of questions asked the respondents about the digital tools and technologies in their education practice. The third group of questions was focused on digitalization aspects and digital wellbeing. The survey included multiple-choice questions, two from the 24 were open-ended questions that allow respondents to answer in open text. These questions were used at the end of the survey.

The questionnaire was developed by the Finnish partner based on a literature review. The questions and the answers offered were then sent to the partners for review and then a final version was produced.

We decided to receive about 40 respondents per country. Unfortunately, except of Czechia, the link was sent to formal network of project partners. In the Czech Republic the link was sent together with personal message to partners with informal relationships. Probably this was the reason, that we received 38 answers from the Czech Republic, 25 from

Slovakia (22 of them based on the Czech questionnaire), 13 from Finland and 4 from other countries. Based on the collected data, we decided to analyze only Czech and Slovak respondents who used the Czech version of the questionnaire (38 from CZ and 22 from SK). All the answers obtained in this way were usable. The Wilcoxon signed rank in program gretl was used to verify statistical significances.

After the questionnaire survey 6 deep interviews were realized. These interviews were unstructured, with only four areas of interest specified, core areas of interest and an expected interview length of 30 minutes. The respondents were mostly people who answered the questionnaire, but this was not a requirement. Each partner conducted approximately 5 interviews with randomly selected respondents. In total, 27 interviews were conducted.

Two research questions were formulated:

RQ1: Using digital tools causes teachers technostress.

The extent of the integration of digital technologies and tools into teaching increased during the Covid pandemic and has not declined to its original level even after it ended. Do teachers feel this negatively?

RQ2: Does digitalization make teachers feel isolated?

The incentives for feeling isolated are quite numerous. It is worth finding out whether they are perceived as such.

3. Results

The five points Likert scale was used (from 1 = strongly disagree, to 5 = strongly agree). Respondents agree that using technology and digital tools in teaching is important. Nevertheless, this is also the only significant difference in the answers of Czech and Slovak respondents (p-value of Wilcoxon signed rank test is 0.003). The respondents also express the belief that they have the most actual digital tools at their disposal and that these tools are safe, see Table 1. P-values verifying differences between answers of Czech and Slovak respondents are included.

Table 1. Digital tools used by university teachers

Questionnaire statements	Czechia (38 resp.)		Slovakia (22 resp.)		Total (60 resp.)		p-value
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.	
I think it is important to use technology and digital tools in teaching	4.16	0.960	4.73	0.538	4.37	0.875	0.003*
In my work, I have up-to-date digital tools at my disposal	3.53	1.019	3.77	0.997	3.62	1.018	0.409
In my work, I have secure digital tools at my disposal	3.84	0.874	4.00	1.000	3.90	0.926	0.384
In my work, I have up-to-date and secure digital tools at my disposal	3.68	0.862	3.95	1.065	3.78	0.950	0.255

* significant at level 0.05

The positive information is that the use of these digital technologies does not cause technostress for them, see Table 2. P-value verifying difference between answers of Czech and Slovak respondents is included.

Table 2. Technostress caused by digital technologies

Questionnaire statements	Czechia (38 resp.)		Slovakia (22 resp.)		Total (60 resp.)		p-value
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.	
The use of technology in teaching makes me feel technostress	2.16	0.987	2.18	1.58	2.17	1.240	0.493

However, the standard deviation for Slovak respondents is very high. It is the highest standard deviation achieved for a single question in the survey. Therefore, it is interesting to compare the answers to the question whether respondents consider the use of technology important and whether the use of technology causes them stress. The responses are presented in Tables 3 and 4.

Table 3. Contingency table comparing the perceived importance of technology in teaching and the technostress exerted by it (Czech respondents)

I think it is important to use technology and digital tools in teaching	The use of technology in teaching makes me feel technostress				
	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Strongly disagree	1	-	-	-	-
Disagree	1	-	-	-	-
Neither disagree nor agree	3	-	2	1	-
Agree	2	6	5	-	-
Strongly agree	4	8	3	1	1

Table 4. Contingency table comparing the perceived importance of technology in teaching and the technostress exerted by it (Slovak respondents of the Czech version of the questionnaire)

I think it is important to use technology and digital tools in teaching	The use of technology in teaching makes me feel technostress				
	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Strongly disagree	-	-	-	-	-
Disagree	-	-	-	-	-
Neither disagree nor agree	-	1	-	-	-
Agree	2	-	-	2	
Strongly agree	11	1	-	2	3

All Slovak respondents consider the use of technology in teaching to be important, although seven of them (31%) find its use technostressing. Respondents from the Czech Republic declared themselves less affected by technostress.

The sense of community has probably been eroded. The mean responses were in the average range, meaning that respondents did not comment negatively on the statement "Increased digitization has reduced the sense of community at my college". The difference between Czech and Slovak respondents is non-significant (p-value of Wilcoxon signed rank test is 0.097). However, they themselves do not feel isolated because of digitalization. This fact is confirmed by the responses to the statement about the invisibility of their work due to digitalization. In general, however, they confirm that digitalization has worsened their interaction with students. The data is presented in Table 5.

Table 5. Feelings caused by increased digitalization

Questionnaire statements	Czechia (38 resp.)		Slovakia (22 resp.)		Total (60 resp.)		p-value
	Average	Std. dev.	Average	Std. dev.	Average	Std. dev.	
Increased digitalization has reduced the sense of community in my organization	3.26	1.287	2.59	1.267	3.02	1.323	0.195
Digitalization in my work has made me feel isolated	2.37	1.132	1.77	1.041	2.15	1.138	0.119
I think because of digitalization, my work is invisible	2.58	1.224	2.14	1.254	2.42	1.256	0.130
Digitalization impairs interaction with students	3.37	1.468	3.36	1.263	3.36	1.402	0.307

4. Discussion

Responses to statements regarding the importance of using digital technology in teaching were the most agreeable across the survey. Nevertheless, here was the only one significant difference between the Czech and Slovak respondent groups. The reason for the stronger agreement of Slovak respondents was not found and is surprising given the very similar educational systems (Urbancová & Urbanec, 2013) and personal ties between Czech and Slovak colleagues. A possible reason is the longer and deeper closure of universities to students and teachers in Slovakia, where the use of these technologies was therefore necessary for a longer period of time.

Statements related to the safety (statement 6) and currency statement 5) of the digital tools used were further in the test confirmed by statements about using safe and up-to-date tools (statement 11). Respondents answered these questions almost equally, so these questions were not explored further.

Answering the RQ1, in the questionnaire, respondents generally disagreed with the statement that using digital technology causes them stress. A more detailed examination through in-depth interviews revealed that respondents did not know the exact meaning of the term technostress or the different causes that can trigger it. Also, Jena (2015) claims that there are more causes of stress. Many interviewees declared the inconveniences associated with the accrued digitalization, in particular the inability to work to a habitual standard because they did not have sufficient mastery of the digital tools used. This is consistent with Nisafani et al. (2020). There was often an invasion of work activities into personal life and uncertainty about whether technology would work when needed. They also appeared to consider stress to be a severe disruption of habitual behavior. Yet, even micro-stress is harmful when applied over a long period of time and its effects add up (Lindstrom et al, 2012).

The longer period of time and the stricter lockdown in Slovakia may also be reasons for the non-significantly (p-value of Wilcoxon signed rank test is 0.119) stronger disagreement of Slovak respondents with the claim that digitalization makes them feel isolated. Given the situation, it was these tools that in 2021, on the contrary, helped them to stay in touch with

both colleagues and students. Slovak respondents were also non-significantly (p-value = 0.130) more likely to disagree that their work was invisible in a digital environment.

The questionnaire responses lead to the conclusion that HE teachers do not feel more isolated due to increasing digitalization, but it is evident that there may be a reduction in sense of community and that interaction with students is deteriorating (RQ2). These results are in contrast to the results of a survey in Sweden (Hakansta, 2022), where the increasing of ICT increased social isolation amongst labor inspectors.

5. Conclusions

Digital well-being is a concept that is not yet widely known. Also, the legislation so far deals with physical rather than mental threats to people at work. At the same time, many employees, including university teachers, work with digital technologies and tools for most of their working hours.

The survey conducted showed that a selected group of respondents consider the use of digital technologies at work to be important and does not cause them excessive stress. They also do not feel isolated or invisibility of the results of their work due to digitalization.

It is good that the respondents consider the tools used to be modern and safe, as well as the fact that they are not stressed. However, it is only their subjective feeling. Similarly subjective as, for example, the feeling about one's own qualities of working with a computer.

Educational institutions should not give up on the implementation of training on how to work with new digital tools, not only from a technical point of view, but also from a mental point of view. Since there are still no legislative rules declaring minimum conditions for digital well-being, it is up to individual institutions to define them.

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Conflict of interest: none

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Emergency Management: A System Dynamics View on the Impact of Disasters in the Corporate Realm

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Abstract: Natural or man-made disasters affect organizations quite often. Similar events can be coped with to a certain extent as organizations have safety plans, protocols and emergency procedures. Their development and application are associated with the discipline of emergency management. Its task is to minimize or even eliminate damages or casualties related to the occurrence of hardly predictable catastrophes. The aim of this paper is to present a system dynamics model enabling decision support for managers during all four stages of emergency management, namely mitigation, preparedness, response and recovery. Based on the search in scientific databases and consequent content analysis, causal-loop and stock-and-flow diagrams were developed. The model consists of six modules. While the first one represents the source related to tsunami generation, the remaining five modules deal with objects of interest such as buildings, infrastructure, environment or people. The model represents a simple and still immature example that demonstrates how the system dynamics methodology can be utilized in this domain in practice.

Keywords: emergency management; disaster; system dynamics; modelling; simulation

JEL Classification: C36; Q54

1. Introduction

The business practice has to deal with different kinds of problems. For various reasons, the influence of disasters on the operation of organizations and their security is becoming more frequent (Suppasri et al., 2022). In some organizations, the traditional approach to occupational safety needs to be intensively expanded to include this aspect. In recent years, the number of disasters, both natural and man-made, have increased very significantly. Due to this fact, the concept of Emergency Management (EM) began to be developed and implemented. According to Huang et al. (2021), EM can be defined as an integrated system composed of various tasks that cover the life cycle of an emergency. The disaster at the Fukushima nuclear power plant of Tokyo Electric Power Company significantly contributed to this development in the Tohoku region of Japan (Kawamura & Narabayashi, 2016). Although this is an extreme disaster, many managers have realized the consequences that natural influences can have on the safety, operability and productivity of the company in case of unprepared or underdeveloped safety protocols (Gisquet & Duymedjian, 2022). Such incidents result in significant loss of life,

destroyed buildings, constrained traffic due to damaged infrastructure, and decreased finances due to repairs or increased cash flows through raising funds such as loans or grants. In summary, it can be stated that the overall economic situation of an affected company is changing. The task of EM is thus to reduce potential losses, to make the response more efficient or to set up mechanisms for quick recovery.

2. Methodology

This work aims to demonstrate how it is possible to work with the effects of disasters using system dynamics as a modelling and simulation methodical approach enabling managers' work to become more efficient (Bureš & Racz, 2016). Based on the example of the nuclear power plant disaster above, a tsunami wave is used as a selected example. The reason for this choice is also the possibility of describing all relationships between elements that have clearly defined relationships (hard systems) and elements for which the exact definition of relationships is complicated (soft systems). The goal is achieved by developing and presenting a model containing selected modules enabling decision making associated with EM activities and processes, which are mitigation, preparedness, response and recovery (Haddow & Haddow, 2014). In general, systems are modelled and investigated using many different methodologies, which can be divided into three groups: traditional statistical methods, artificial intelligence methods and simulation methods (Huang et al., 2021). The choice of method depends on the nature of the given problem. Traditional methods include, for example, experience-based analysis, time series analysis, a model based on fuzzy theory, or a Bayesian network. Artificial intelligence methods use learning mechanisms that learn from historical data and situations or neural network-based mechanisms. These methods provide a more accurate and comprehensive description of the system. Simulation methods are a very effective tool for displaying the complexity of the emergency system. When creating simulation models, we encounter many problems that affect several areas, such as geology, economics, transport or infrastructure, and all these areas need to be considered. These methods include simulations based on physical phenomena or multi-agent simulations (Bureš & Tučník, 2014; Lee et al., 2022). Based on searches using the keywords Tsunami, Influence, Economy and System Dynamics, relevant papers were identified in the databases of Scopus, Science direct, and SpringerLink, which were then analyzed to identify the critical variables needed to create a causal-loop diagram (CLD) and stock -and - flow diagram (SFD). The Stella Professional application was used for this purpose. The creation of the model and its simulation respected the methodological procedure emphasizing the principles and the order of creating these diagrams and the implementation of subsequent analyzes (Barlas, 2018). The time unit was determined to be one hour, representing a compromise between the speed of the disaster and the speed of reaction and implementation of corrective actions.

3. Model Development

The qualitative modelling based on creating a CLD diagram was the first step. The main variables that emerged as the most important in the primary literature search were listed. Iteratively, the variables were modified and expanded into the final form of the diagram.

The CLD diagram is based on the following reasoning. An earthquake under the sea causes a wave and increases its volume and, subsequently, the height of the wave. Due to its height, the wave spreads to the coast and affects the residents, buildings and other assets of the company. The larger the affected area, the more people will be injured, lives lost, property damaged and the damage caused in general. After a disaster strikes, it is common to activate financial flows. The larger and more destructive the disaster, the more money must be allocated. This money is then invested in materials, supplies and post-disaster repairs. Recovery can also be financed, for example, by state authorities in the form of subsidies. The second step was transforming the CLD into an SFD diagram, which enabled quantification and subsequent simulation. As part of this step, the following modules were identified: The formation of the Tsunami (hereafter Tsunami), People, Buildings, Infrastructure, Finance and Environment.

The formation of the Tsunami module represents the only part of the model that does not relate to the company's own environment and is considered a fully exogenous variable. But its creation was necessary for the purposes of a meaningful wave simulation. For the sake of simplicity, only earthquakes are considered the cause of tsunamis. Similarly, the Environment module is perceived as an additional one not directly related to business problems (except for cases of a specific type of enterprises dependent on the surrounding environment such as agriculture, mining etc. The interconnection of the modules can be seen in Figure 1.

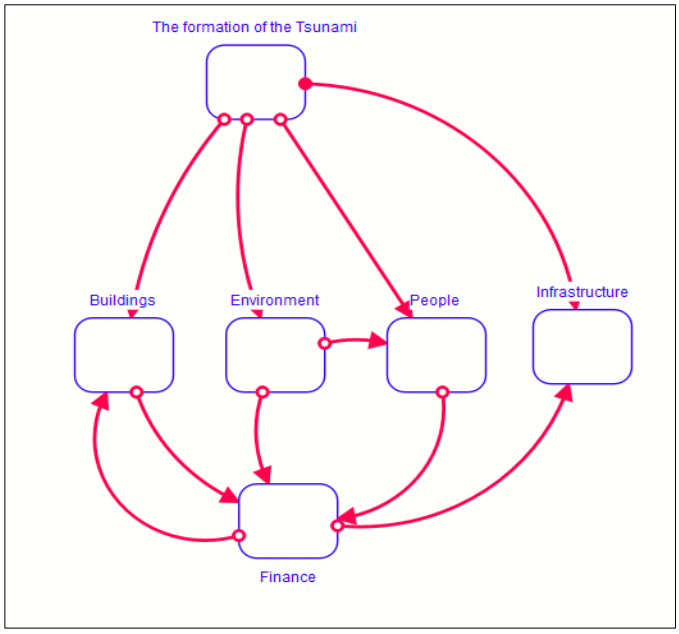

Figure 1. Structure of modules

Table 1 presents the content of the individual modules with a focus on stocks, existing arrays, essential converters and sources from which the creation of the individual diagrams in the modules was based on.

Figure 2 below is used for demonstration purposes only as it provides an example of SFD diagram in the People module. Interlinking with Tsunami and Environment modules from Figure 1 is ensured by the converters Flow velocity of the run-up and Contaminated Water.

Table 1. Model elements

Modules	Stocks	Arrays	Key Converters	Resources
The formation of the tsunami	Wave amplitude	N/A	Wave height; Phase velocity of the wave; Distance to shore; Wave run-up; Flow velocity of the run-up; Maximum run-up height; Inclination of the coast; Inundation distance	Röbke & Vött (2017); Smart et al. (2016); Thran et al. (2021)
People	Population; Affected population; Injured people; Unharmed people; Dead people; Rescuers; Paramedics in the area; All available paramedics	N/A	Rate of impact; Population density in the area; Share of paramedics; Injury rate; Mortality rate; Cure rate	Takabatake, Esteban, & Shibayama (2022); Chiu et al. (2020)
Buildings	Buildings; Damaged buildings; Destroyed buildings; Repaired buildings	Types of buildings: Sheet metal and wood buildings, Brick buildings, Larger reinforced brick buildings, Buildings with unreinforced concrete structures, Buildings with a reinforced concrete structure Types of damage: Slight damage, Medium damage, Severe damage, Very severe damage of construction	Average level of damage; Average level of destruction; Intensity of destruction; Rate of destruction	Ghobarah et al. (2006); Rossetto et al. (2007); Leone et al. (2011)
Infrastructure	Communications; Destroyed communications; Repaired communications; Water pipes; Destroyed water pipes; Power cables; Destroyed power cables; New columns and cables	Types of communications: Roads, Railways Types of water pipes: Plastic, Copper, Steel Columns: Material – Wooden, Concrete, Metal Height: <5m, 5-10m, 10m<	Destructiveness	Ghobarah et al. (2006); Leone et al. (2011)
Finance	Available financial resources; Costs of damage; Finance allocated; Financial support	Finance allocation: Food, Infrastructure recovery, Water, Healthcare, Shelter, Defensive elements	Value of damage; Subsidies; Number of contributors	Heger & Neumayer (2019); The Guardian (2014)
Environment	Dead animals; Contaminated water; Destroyed coastal and sea life; Waste in the sea	Vegetation: Coral reefs, Marine plants, Mangrove forests, Coastal vegetation Waste in the sea: General waste, Soil, Debris	Mortality from dehydration; Length of the coast	Srinivas & Nakagawa (2008); Thanawood et al. (2006)

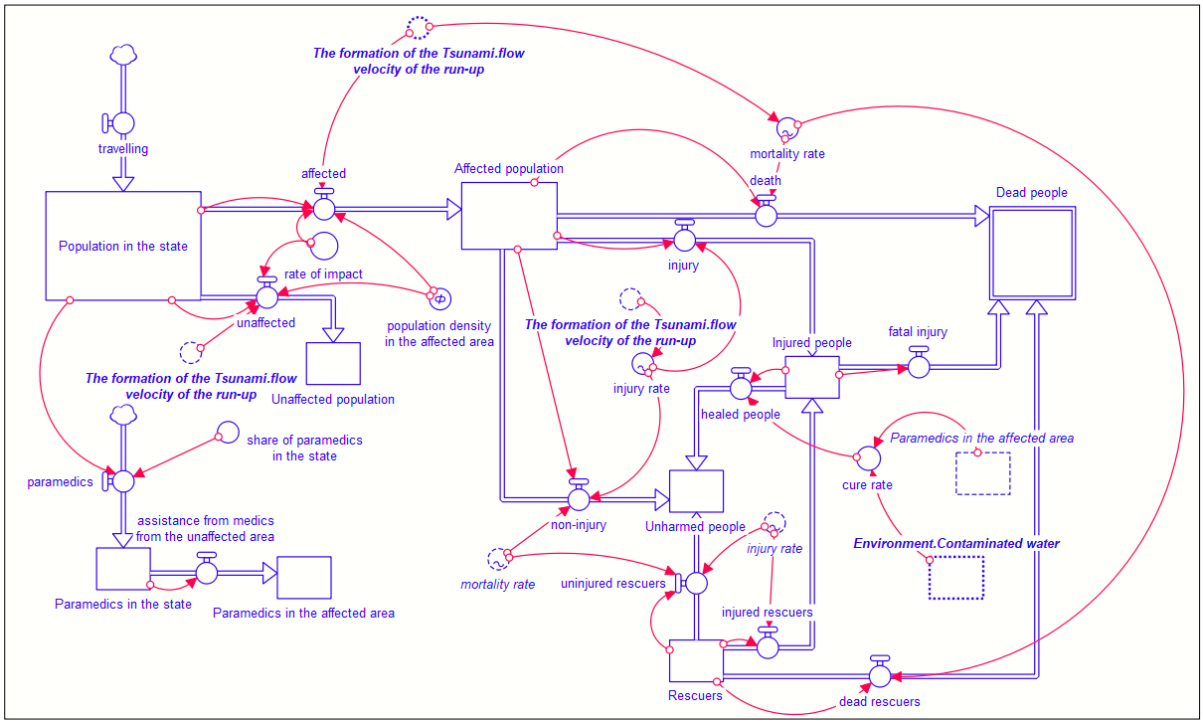

Figure 2. People module

4. Simulation

Although not a corporate sector, the validation of the model is based on the existence of the tsunami in the Indian Ocean in the region of Indonesia, which took place in 2004. However, there are variables; for instance, in the Environment module, for which the values from the actual situation in the Indian Ocean are not recorded. In these cases, it is impossible to check whether the simulation results correspond to the actual situation.

Nevertheless, the Environment module is not the most significant one. For the People module, there are recorded statistics regarding the casualties and injured people due to the wave impact. In this case, the model's simulation results can be compared with the actual data. The simulation results of the model in Figure 3 correspond to the real data. For example, the model shows that roughly 24,000 people died from the affected section examined in the model, which roughly corresponds to the real data.

The next module focuses on Buildings in the impacted area. In Figure 3, only buildings with slight damage are presented because if all possible combinations of buildings and damage types were in the figure, it would become unreadable and messy. It is possible to see here that the most damaged buildings are from ordinary buildings made of wood and metal, and the fewest are from the group with reinforced construction. We can also find out that the buildings are destroyed only in the first few hours. After about a day, the value of some groups of buildings will start to decrease as they start to be repaired, but these are the most common buildings and the repairs will also be temporary.

The behavior of the Infrastructure module in time is captured in Figure 4, where the most critical outputs are the values related to destroyed roads, water pipes and power cables, or more precisely, the poles on which these cables hang. As seen in Figure 4, the communication

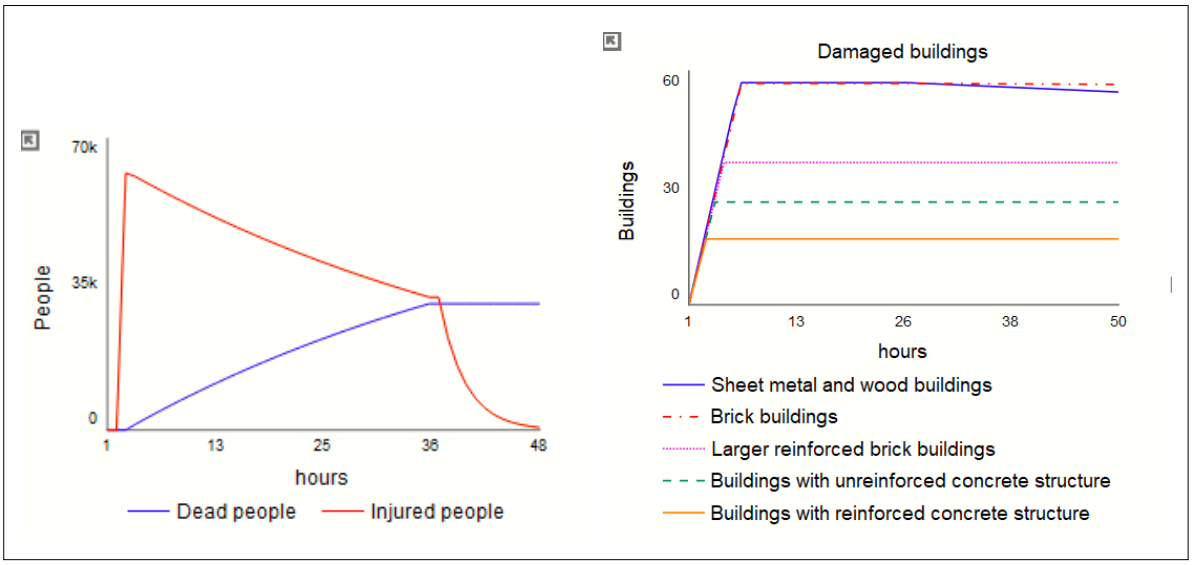

Figure 3. Simulation in the People and Buildings module

will be damaged within the first few hours. Still, it is clear that, when the wave goes away, the repairs (minimum repairs needed to make the communication usable again) will happen quickly. Furthermore, power cables on low and wooden poles will be destroyed the most, while the least damage will occur on high metal poles. We can also find out that the poles with electric cables started to be repaired slowly, but only the low and wooden ones. For water pipes, the plastic ones are the most destroyed and the metal ones are the most durable.

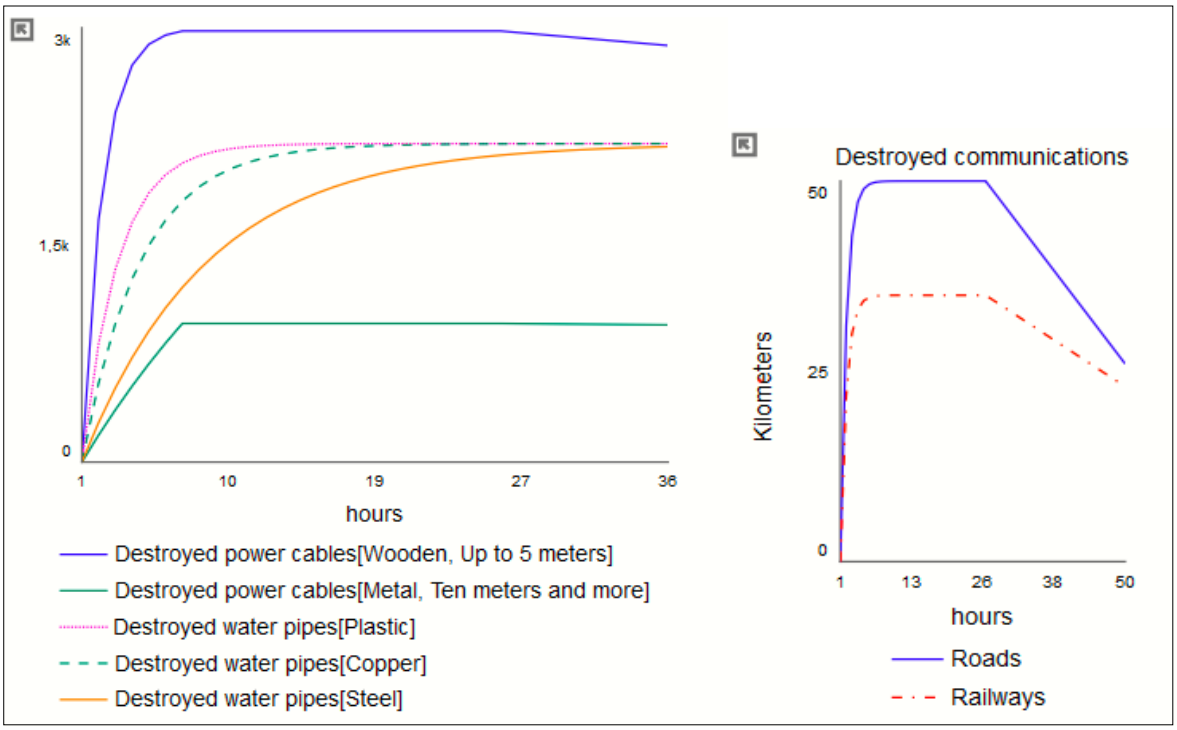

Figure 4. Simulation in the Infrastructure module – Communication and Infrastructure

5. Sensitivity Analysis and Robustness Test

The most significant variables for the sensitivity analysis can be identified mainly in the Tsunami module, as this module is the source of the whole event and dramatically influences the other modules. However, for the purpose of the sensitivity analysis, the Inclination of the

module water surface converter from the Tsunami module and the Population density converter from the People module were identified.

The values of the variable Inclination of the water surface show that if the slope of the water surface increases even slightly, then the wave onset speed will be much higher, affecting the impact rate in the area and the mortality rate. From the provided example, it is possible to find out that after increasing the slope of the water surface from 0.00021025 to 0.0004 radians, casualties increase by 10,000 people. Due to the interconnectedness of the model, this also has a secondary effect on the Finance module, because the more casualties, the more finance resources will be allocated to the affected area. Population density represents another variable to which the model is sensitive. This is quite obvious because the higher the population density in the affected area, the more dead and injured will be. In the validation example, when the population density increases from 0.116 people/m² to 0.5 people/m², the number of disaster victims increases by 5,000.

We can look for the most suitable variables for the robustness test in the Tsunami module again. The goal of this test is to prove that the model works as expected under extreme conditions. The simulation of the model will not take place at all, for example, if the Inundation depth is zero, because at that moment, the tsunami wave did not occur at all, and there will be no casualties or injuries. Another example where the model will not work is when the Tsunami starts at a depth of 200 (variable Water depth). In this case, the place of the source of the tsunami would be too close to the coast and there would not be enough space to gain height and speed. All settings of the robustness test support the validity of the model.

6. Conclusions

This work emphasizes the need for the development of emergency management and, above all, the possibility of application of simulation models employing system dynamics methodology. Although the model replicates historical data, it does not mean that the model could not be created in another way. In fact, the model has to be considered immature and able to provide initial demonstrations. For example, one of the possibilities for further development is the linking of the Tsunami module and other modules using the Imammura variable Lida magnitude scale, described in the relevant literature. Another possible extension could be to create a module focused on defence mechanisms and tools. Each organization has different conditions, the spatial layout of buildings, the concentration of workers in different premises or financial possibilities to implement existing ways to slow down the tsunami wave and thus reduce the subsequent loss of life and damage. Conditions are already prepared for this module that considers finances, namely at the level where finances are allocated into particular areas. One of the areas where the money can be spent is implementing defence elements. This statement can, of course, be generalized to any type of disaster, not just the example of tsunamis. If the model is extended in this way, it could serve as a tool for EM in preparing for a disaster. It would be possible to determine which types of defense tools are the best solution for a given area and, at the same time, to which extent it must be implemented. An extension can also consist of connecting to automated data processing or analytical tools that are commonly used in other areas, e.g. reporting tools or

ambient intelligence and smart environment methods and technologies (Mikulecký et al., 2011) or developing easily searchable and properly organized corporate web pages (Bartuskova & Soukal, 2016) presenting related information to all employees in the organization. However, this path of development is strongly associated with technological readiness and ICT investments (Svobodova & Hedvicakova, 2017). Finally, an extension of the source module with other types of tsunamis, such as meteotsunami, would be beneficial. The existence of elements for which the end state of the simulation is not determined represents one of the existing shortcomings of the model. In other words, the simulation of the given element continues, but after some time, the values no longer correspond to reality. Therefore, it is significant to consider how long we set the simulation time. Overall, in each module, it is essential to set the simulation time to suit the module, as the results are visible after a different period of time each time. For example, when a wave strikes, we see the value of injured people right away, but the value of repaired buildings will be apparent only after a long time. One of the possible solutions could be based on the separation of modules into separated modules providing data which can be exported to a model with longer simulation time periods. Furthermore, values of various variables have to be estimated as actual data are not available. However, it is anticipated that data would be at hand in case of implementation in particular organizations.

The model shows the effects of a disaster on an organization's life in the affected area. Therefore, it could be used as a helpful tool for the crisis manager in all phases of the emergency situation, i.e. preparation and prevention, response and subsequently in dealing with the consequences of a disaster that has already taken place, specifically for the distribution of resources and aftermath. It can support managers in making complex and significant decisions in emergency situations.

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Impact of China's Energy Internet Development on Carbon Emission Reduction

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Abstract: This paper explores the impact of China's energy Internet development on carbon emission reduction and its internal transmission mechanism, and uses panel data of 30 provinces from 2000 to 2020 to construct comprehensive development indicators of energy Internet through entropy weight method for empirical test. The results show that the development of energy Internet can promote carbon emission reduction, and the increase of renewable energy utilization is an important mechanism for the comprehensive development level of energy Internet to restrain carbon emissions. The heterogeneity analysis shows that, according to the degree of carbon emissions, the energy Internet has obvious effect on carbon emission reduction in regions with low carbon emissions and regions with moderate carbon emissions. According to economic region, the development of energy Internet can significantly curb carbon emissions in the western region. Finally, it is found that in the context of the development of energy Internet, the development of renewable energy can promote the consumption of natural gas and improve the efficiency of energy conversion. In addition, the government's emphasis on regional technological development can bring external reinforcement effect on carbon emission reduction. The research expands the discussion of diversified carbon emission reduction paths, promotes the explanation of the effect and influence mechanism of energy Internet to promote carbon emission reduction, and helps to provide beneficial policy enlightenment for the adjustment of the layout of energy Internet in China to better help achieve the goal of carbon neutrality.

Keywords: energy internet; carbon emission; renewable energy; mediating effect

JEL Classification: O10; O13

1. Introduction

In China, fossil energy, as the dominant energy source, has played an important role in promoting economic and social development. However, this energy mix also brings a lot of carbon emissions. At present, in the context of energy saving and emission reduction as the main melody of economic development and carbon peak and carbon neutralization, our carbon emission reduction situation is not optimistic. At present, China is still the largest developing country and carbon emitter in the world, and there is still a long way to go to promote the process of carbon emission reduction (Li et al., 2022). The root cause of the carbon emission problem is the massive development and use of fossil energy. The solution is to change the mode of energy development and completely get rid of the dependence on fossil energy.

The purpose of building energy Internet is to increase the proportion of renewable energy and the utilization efficiency of traditional fossil energy, fundamentally change the current energy consumption pattern, and then change the decoupling of economic development from the demand for fossil energy and play a role in energy conservation and emission reduction while improving the comprehensive utilization efficiency of energy. The construction of energy Internet is to lead the carbon emission reduction of the whole society with the zero-carbon revolution of the energy system, which plays an overall and leading role in the development strategy of achieving carbon peak and carbon neutrality. Therefore, scientific assessment of the impact of the development of China's energy Internet on carbon emissions and improvement of the development layout of energy Internet to support the progress of carbon emission reduction are urgent problems to be faced and solved.

At present, the research on carbon emission reduction path mainly focuses on three aspects: market mechanism design, digital economy and clean energy. First of all, existing studies believe that the design of market mechanism is conducive to promoting carbon emission reduction (Wang et al., 2019; Wettestad & Jevnaker, 2019; Yu et al., 2020). Secondly, the rapid development of the digital economy can also help reduce carbon emissions (Park, 2018; Moyer & Hughes, 2018; Asongu et al., 2018; Shahbaz et al., 2022). Finally, there are studies on the relationship between clean energy development and carbon emissions. Clean energy development can significantly reduce carbon dioxide emissions (Lu et al., 2013; Dogan & Seker, 2016; Awanet al., 2022). The energy internet is rarely considered in the research of carbon emission reduction effect. Digitalization also inhibits carbon emissions to a certain extent (Yang et al., 2022; Fan, 2022).

The research on the energy Internet is currently focused on the global level, and most of the literature focuses on the development of the global energy Internet (Liu, 2016; Yang et al., 2019; Laroussi, 2022). There are a few literatures that discuss the development of China's energy Internet, and more focus on its business model, technical architecture and implementation path (Yu et al., 2019; Gqa et al., 2021). There is still a research gap in analysing carbon emission reduction effects from the perspective of energy Internet, especially China's energy Internet. The development of energy Internet and energy reform are closely related to carbon emissions. Therefore, the purpose of this study is to identify the impact of China's energy Internet development on carbon emissions reduction. In order to achieve this, it is necessary to solve the following tasks: (1) Identify the carbon emission reduction effect of China's energy Internet development; (2) Explore the internal transmission mechanism of carbon emission changes caused by the development of China's energy Internet; (3) This paper examines the regional heterogeneity of different factor endowments and the externalities brought by the regional government's emphasis on scientific and technological development. In view of this, the marginal contribution of this paper is: (1) It fills the gap of carbon emission reduction research in China's energy Internet development, broadens the research on diversified carbon emission reduction paths, and provides new ideas for China to achieve the carbon peak before 2030 and carbon neutrality by 2060. (2) The theoretical and practical explanation of the effect and influence mechanism of the development of energy Internet in promoting carbon emission reduction is

supplemented, and the heterogeneous results are identified. This not only helps to clarify the work priorities of the construction of energy Internet in each province, but also promotes the adjustment and improvement of the layout of energy Internet. (3) By deepening the research on the emphasis of regional governments on scientific and technological development, the government's role in promoting the development of the energy Internet has been clarified. This will provide reference for the government to adjust its development strategy in promoting the positive relationship between energy Internet and carbon emission reduction.

2. Theoretical Part

In 2004, the Economist magazine published building the energy internet and proposed whether we can learn from the self-healing and plug-and-play digital network of the information internet to build an energy internet, which is the bud of the energy internet. With the development of distributed generation and new electronic technologies, the energy internet has been recognized and developed. Today, the energy internet can be considered as a complex multi-network flow system formed by taking the power system as the core, the internet and other cutting-edge information technology as the basis, and the distributed renewable energy as the main primary energy, and closely coupled with natural gas network, transportation network and other systems (Dong et al., 2014). The construction of energy Internet can reduce information asymmetry, optimize resource allocation, realize cross-regional coordinated utilization of coal, electricity, gas, hydrogen and other energy, and improve the efficiency of energy use. The use of energy Internet can realize joint dual control of energy and carbon emissions, contribute to the detection and traceability of carbon emissions, promote the development of carbon reduction technology, and promote low-carbon and green development. Therefore, this paper proposes the first research hypothesis.

H1: The development of energy Internet can promote carbon emission reduction.

China's coal-based energy system and high-carbon industrial structure make its total carbon emission and carbon intensity present a state of "double high". At present, China's coal consumption still accounts for more than 50%. To solve the problem of carbon emissions, we need to change the mode of energy development, adjust the structure of energy consumption, and increase the proportion of clean energy and renewable energy. The development of energy Internet can promote the diversity of energy supply. Renewable energy such as wind power, solar power and waterpower play a certain role in replacing coal, oil and other energy sources. However, the utilization of these renewable energy sources produces less carbon dioxide than traditional fossil energy sources, which can promote carbon emission reduction. Based on this, this paper proposes a second research hypothesis.

H2: The energy Internet can curb the increase of carbon emissions by promoting the use of renewable energy.

3. Methodology

3.1. Model Design

Benchmark regression model. Based on the above theoretical analysis and research assumptions, this paper constructs the following fixed-effect model of panel data:

$$\mathrm{Y_{it}} = \alpha_0 + \alpha_1 \mathrm{EDI_{it}} + \alpha_2 \sum Control_{it} + \xi_t + \varepsilon_{it} \quad (1)$$

where *i* represents the province, *t* represents the year, Y_{it} represents the carbon emissions of province *i* in *t* years, EDI_{it} represents the comprehensive development level of energy Internet of Province *i* in *t* years, $Control_{it}$ represents the control variable affecting carbon emissions, ξ_t represents the fixed effect of year, and ε_{it} represents the random error term.

Mediation effect model. Based on the analysis of theory and influence mechanism, this paper constructs the following mediation effect model:

$$\ln RE_{it} = \beta_0 + \beta_1 EDI_{it} + \beta_2 \sum \mathrm{Control}_{it} + \xi_t + \varepsilon_{it} \quad (2)$$

$$\mathrm{Y_{it}} = \lambda_0 + \lambda_1 \mathrm{EDI_{it}} + \lambda_2 \ln \mathrm{RE} + \lambda_3 \sum \mathrm{Control_{it}} + \xi_t + \varepsilon_{it} \quad (3)$$

In equations (2) and (3), $lnRE_{it}$ represents the renewable energy utilization in t years of I province after logarithm. In this paper, stepwise regression method will be used for identification. Firstly, Equation (1) will be tested. If the coefficient α_1 is significant, subsequent testing steps will be carried out. Then, the regression of equation (2) is carried out. If the coefficient β_1 is significant, continue to the next step. Finally, equation (3) is regression, if the coefficients λ_1 and λ_2 are both significant, it indicates that there is a partial mediating effect. If λ_1 is not significant but λ_2 is significant, it indicates that there is a complete mediating effect.

3.2. Selection of Indicators

Explained variable. The explained variables in this paper are carbon emissions (CE), and carbon emissions per capita (CEPC) and carbon emissions per unit of GDP (CEPUG) are also used in the baseline regression. Carbon emissions per capita are measured by the ratio of carbon emissions to the total population, and carbon emissions per unit of GDP is measured by the ratio of GDP and carbon emissions, and the logarithm of these variables is taken for regression.

Core explanatory variable. The core explanatory variable of this paper is the comprehensive development level of energy Internet. Based on the index construction method proposed by Ge (2019) and Zhang (2018), The comprehensive development level of energy Internet is constructed from three aspects: smart grid development (system1), clean energy development (system2) and coordinated development of energy economy (system3). The specific indicators are shown in Table 1.

Table 1. Index System of Comprehensive Development Level of Energy Internet

First index	Secondary index	Third index	Data sources
Smart grid development index	Infrastructure construction	Ratio of installed capacity of thermal power generation to total installed capacity	China Electric Power Yearbook
		Human capital development (education expenditure/total financial expenditure)	China Statistical Yearbook
	Power grid development	Capacity of power generation equipment	China Electric Power Yearbook
		Generating capacity	China Electric Power Yearbook
	Popularization of electricity	Electricity consumption	China Electric Power Yearbook
		Per capita electricity consumption	China Electric Power Yearbook
	Smart grid importance	The government's emphasis on smart grid (measured by the frequency of smart grid related keywords in the government work report)	Government Work Report
Clean Energy Development Index	Clean energy priority	The government's emphasis on clean and renewable energy (measured by the frequency with which keywords related to clean and renewable energy appear in the Government Work report)	Government Work Report
	Percentage of installed capacity	The proportion of installed capacity of non-fossil energy in total installed capacity	China Electric Power Yearbook
	Power generation ratio	Non-fossil energy power generation capacity accounts for the province's total power generation ratio	China Electric Power Yearbook
Energy Economic Coordination Index	Macroeconomics	GDP per capita	National Bureau of Statistics of China
		GDP growth rate	National Bureau of Statistics of China
	Quality of environment	PM2.5	Atmospheric Composition Analysis Group of Washington University measured the global surface PM2.5 concentration
		Industrial sulfur dioxide emissions	China Environmental Yearbook
		Comprehensive utilization of industrial solid waste	China Environmental Yearbook
	Energy consumption	Total energy consumption	China Energy Statistical Yearbook
	Energy efficiency	Energy efficiency (GDP/ energy consumption)	China Energy Statistical Yearbook

Control variable. In order to control the influence of other factors on carbon emission reduction, the following control variables are selected in this paper according to previous studies: urbanization level (UL), which is measured by the ratio of urban population to total population, and logarithm is taken for this index; Industrial structure (IS), measured by the

ratio of the added value of the secondary industry to the gross national product; Technical level (TEC), expressed by the number of patents granted annually; Fiscal decentralization (FD), measured by the ratio of fiscal expenditure to fiscal revenue, logarithm of this index; The level of foreign investment (FDI) is measured by the ratio of total foreign investment to GDP. In addition, industrial sales value (ISV) and Coal consumption of industrial enterprises above designated size are also controlled, and the logarithm of these two indicators is taken.

Mediation variables. Renewable energy. Due to the lack of direct data on renewable energy, this paper uses the power generation of renewable energy, mainly including wind power generation, solar power generation and hydropower generation.

3.3. Source of Data

Due to the lack of some data in Tibet, this paper selects panel data from 2000 to 2020 from 30 provinces except Tibet and Hong Kong, Macao and Taiwan. The data of provincial carbon emissions are from China Carbon Accounting Database (CEADs), the data of control variables are from National Bureau of Statistics of China, and the data of intermediary variables are from China Electric Power Yearbook. Descriptive statistics of the main variables are shown in Table 2.

Table 2. Descriptive statistics of main variables

variable	mean	sd	min	max
lnCE	9.858	0.988	4.400	12.17
lnCEPC	0.775	0.792	-1.851	2.552
lnCEPUG	1.693	0.784	-2.074	4.01
EID	0.292	0.133	0.0790	0.752
lnUL	-0.717	0.320	-1.761	-0.110
IS	0.426	0.0810	0.160	0.620
TEC	3.225	6.761	0.00700	70.97
lnFD	0.749	0.384	0.0500	1.909
FDI	0.521	1.441	0.0430	34.02
lnISV	8.969	1.419	5.200	11.96
lnCoal	8.962	0.962	5.208	10.85
lnRE	4.939	2.533	-2.408	15.12

4. Results

4.1. Basic Empirical Results

Table 3 reports the regression results of the influence of energy Internet development on carbon emission reduction. From columns (1) to (3), it can be found that the estimated coefficients of the comprehensive development level of energy Internet on emissions, carbon emissions per capita and carbon emissions per unit of GDP are -0.292, -0.257 and -0.302, respectively, and are significantly negative at the 5% level, indicating that the development level of energy Internet will inhibit the increase of carbon emissions. The higher the development level of energy Internet, the better the effect of carbon emission reduction. Column (4) ~ (6) shows the impact of the three subsystems of the comprehensive

development level of energy Internet on carbon emission reduction. It can be found that compared with other subsystems, the development level of clean energy has a greater impact on carbon emission, which is significantly negative at the level of 1%, indicating that the development level of clean energy plays a greater role in the comprehensive development level of energy Internet.

Table 3. Results of baseline regression

	(1)	(2)	(3)	(4)	(5)	(6)
	lnCE	lnCEPC	lnCEPUG	lnCE	lnCE	lnCE
EID	-0.292**	-0.257**	-0.302**			
	(-2.31)	(-2.05)	(-2.44)			
system1				-0.0567		
				(-0.77)		
system2					-0.575***	
					(-5.81)	
system3						0.709***
						(3.24)
Constant	2.749***	-6.541***	-4.355***	2.730***	2.814***	2.883***
	(3.55)	(-8.49)	(-5.75)	(3.51)	(3.74)	(3.74)
Control variable	Yes	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes	Yes
N	504	504	504	505	504	505
R^2	0.844	0.830	0.683	0.842	0.853	0.845

Note: Standard errors in parentheses, * p < 0.1, ** p < 0.05,*** p < 0.01

4.2. Influence Mechanism Test

The above analysis analyses the influence of the comprehensive development level of energy Internet on carbon emission reduction from the theoretical level. In order to verify the hypothesis of the influence mechanism, this paper chooses the intermediary effect model for testing, and the regression results are shown in Table 4. On the basis that formula (1) confirms that the comprehensive development level of energy Internet will promote carbon emission reduction, formula (2) verifies whether the comprehensive development level of energy Internet will promote the utilization of renewable energy. The estimated coefficient of the comprehensive development level of energy Internet in column (2) is positive at the level of 5%. It shows that the comprehensive level of energy Internet will promote the use of renewable energy. Finally, the intermediary variable of renewable energy is put back into the regression equation of the influence of the comprehensive development level of energy Internet on carbon emission reduction, and the coefficient value and significance level of the core explanatory variable are observed for judgment: The influence coefficient of the comprehensive development level of energy Internet in column (3) is lower than that in column (1), indicating that the increase of renewable energy utilization is the influence mechanism of energy Internet to promote carbon emission reduction.

Table 4. Influence mechanism

	(1)	(2)	(3)	(4)
	lnCE	lnRE	lnCE	lnCE
EID	-0.292**	2.321**	-0.232**	-0.225*
	(-2.31)	(2.15)	(-1.99)	(-1.86)
lnRE			-0.0105**	-0.0128**
			(-2.13)	(-2.43)
Constant	2.749***	-1.017	1.217***	0.840*
	(3.55)	(-0.42)	(4.34)	(1.94)
Control variable	Yes	Yes	Yes	Yes
Year	No	No	No	No
Code	No	No	No	Yes
N	504	493	493	493
R2	0.844	0.133	0.833	0.834

Note: Standard errors in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01

5. Discussion

5.1. Test of Heterogeneity

The comprehensive development level of energy Internet may have different impacts on regions with different levels of carbon emissions. Therefore, this paper divides 30 provinces and cities into low emission zones, medium emission zones and high emission zones according to the carbon emissions. The regression results are shown in Table 5. From columns (1) to (3), it can be seen that the comprehensive development level of energy Internet has a better effect on carbon emission suppression in low emission areas and medium emission areas, especially medium emission areas, but it has no obvious effect on carbon emission reduction in high emission areas. In addition, dummy variables are also set according to the situation of power grid science and technology information management in each province. The provinces with power grid science and technology information planning are marked with 1, while those without are marked with 0. From columns (4) to (5), it can be seen that the situation of power grid science and technology information management in each province does not affect the effect of comprehensive development level of energy Internet on carbon emission reduction.

Table 5. Heterogeneity effects of carbon emission and power grid planning

	(1)	(2)	(3)	(4)	(5)
	low	medium	high	have grid planning	without grid planning
	lnCE	lnCE	lnCE	lnCE	lnCE
EID	-0.568**	-0.236***	0.223	-0.271*	-0.395*
	(-2.11)	(-2.66)	(1.43)	(-1.90)	(-1.77)
Constant	-3.177*	4.354***	7.294***	-0.0507	1.167
	(-1.82)	(6.12)	(5.76)	(-0.05)	(0.87)
Control variable	Yes	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes	Yes
N	166	169	169	369	135
R2	0.821	0.973	0.915	0.817	0.936

Note: Standard errors in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01

Different provinces have different influences due to differences in politics, economy, culture, resources and other factors. In this paper, the 30 provinces are divided into four regions: Eastern region, central region, western region and Northeast region. The eastern region includes Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan, and the central region includes Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan. The western region covers Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Xinjiang and Ningxia, while the northeastern region covers Heilongjiang, Jilin and Liaoning. It can be seen from Table 6 that the comprehensive development level of energy Internet can significantly promote carbon emission reduction in the western region, while the effect of carbon emission reduction in other regions is not significant. This may be because the western region is rich in clean energy such as wind and solar energy, which can better replace traditional energy.

Table 6. Regression by region

	(1)	(2)	(3)	(4)
	east	middle	west	northeast
	lnCE	lnCE	lnCE	lnCE
EDI	-0.117	-0.183	-1.009***	0.111
	(-0.78)	(-0.74)	(-3.58)	(0.82)
Constant	2.253**	6.682**	-2.631*	6.164***
	(2.05)	(2.00)	(-1.69)	(2.93)
Control variable	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
N	168	101	184	51
R2	0.912	0.916	0.860	0.993

Note: Standard errors in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01

5.2 Further Analysis

Energy consumption and energy conversion efficiency under the development of Energy Internet. In order to further explore the impact of the development of renewable energy on energy consumption and energy conversion efficiency under the background of the development of energy Internet, this paper constructs the interaction term of the comprehensive development level of renewable energy and energy Internet as the explanatory variable. The explained variables were the consumption of natural gas and the energy conversion efficiency. The energy conversion efficiency of each province was calculated by multiplying the provincial education expenditure to the national education expenditure as the weight and multiplying the national energy conversion efficiency. The regression results are shown in Table 7. Columns (1) and (2) show that the development of renewable energy can promote the consumption of natural gas, natural gas plays a certain role in replacing oil, coal and other energy sources, and natural gas, as a kind of clean energy, can effectively reduce carbon emissions. Column (3) and (4) indicate that the development of renewable energy can promote the improvement of energy conversion efficiency. The higher the energy conversion efficiency, the more thorough the utilization of energy.

Table 7. The impact of renewable energy on energy consumption and energy conversion efficiency

	(1)	(2)	(3)	(4)
	natural gas	natural gas	energy conversion efficiency	energy conversion efficiency
EDI*lnRE	0.291**	0.257***	0.0179*	0.0180**
	(2.11)	(3.01)	(1.78)	(2.00)
Constant	-0.441	17.54***	0.662***	-0.529
	(-1.16)	(6.04)	(31.45)	(-0.98)
Control variable	No	Yes	No	Yes
year	Yes	Yes	Yes	Yes
N	588	493	389	298
R2	0.481	0.630	0.0398	0.388

Note: Standard errors in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01

Table 8. Externalities

	(1)	(2)	(3)	(4)
	lnCE	lnCE	lnCE	lnCE
EDI	-14.81***			
	(-3.13)			
system1		-4.824		
		(-1.52)		
system2			-21.37***	
			(-4.57)	
system3				-7.528*
				(-1.91)
Constant	3.027***	3.024***	3.045***	2.682***
	(3.76)	(3.73)	(3.83)	(3.27)
Control variable	Yes	Yes	Yes	Yes
year	Yes	Yes	Yes	Yes
N	493	494	493	494
R2	0.846	0.843	0.850	0.844

Note: Standard errors in parentheses, * p < 0.1, ** p < 0.05, *** p < 0.01

Externality of the degree of emphasis on regional technology development. Local development cannot be achieved without the support of the government, and the development of energy Internet needs the support of technology. This paper further studies whether the government's emphasis on regional technology development can bring external reinforcement effect on carbon emission reduction. The importance the government attaches to regional technology development is measured by the proportion of local science and technology expenditure in local general budget expenditure, and an interaction term is constructed with the comprehensive development level of energy Internet and the three subsystems as explanatory variables. The regression results are shown in Table 8. The comparison between the results in column (1) and the baseline regression shows that the government's emphasis on regional technology development can promote carbon emission reduction. It can be seen from column (3) and (4) that, for the two subsystems of clean energy development level and coordinated development level of energy economy, the government's attention can also promote carbon emission reduction. However, the interaction coefficient between the development level of smart grid and the government's emphasis on regional technology development is not significant. The government should strengthen the construction of smart grid.

6. Conclusions

This paper establishes the comprehensive development level index of energy Internet and studies the influence of the development of energy Internet on carbon emission reduction. Through the empirical test, it is found that the development of energy Internet can effectively promote carbon emission reduction, but the development level of smart grid and the coordination level of energy economy cannot promote carbon emission reduction. The analysis of influence mechanism shows that the comprehensive development level of energy Internet can restrain the increase of carbon emissions mainly by promoting the utilization of renewable energy. Heterogeneity analysis shows that the development of energy Internet has a more significant effect on carbon emission reduction in low and medium emission zones. In the four regions, the comprehensive development level of energy Internet in the western region can significantly restrain carbon emissions. Finally, through further research, this paper finds that in the context of the development of energy Internet, the development of renewable energy can promote the consumption of natural gas and improve the efficiency of energy conversion. In addition, the government's emphasis on regional technological development can bring external strengthening effect on carbon emission reduction. The higher the emphasis, the better the effect of carbon emission reduction.

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Conflict of interest: none

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Analysis of Sustainable Energy Development Paths in Northwest China from the Perspective of Energy Revolution

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Abstract: The period of the fourteenth Five-Year Plan is critical for the growth of China's energy revolution. As an energy-rich region of China, Northwest China offers inherent advantages for the growth of the energy industry. China will be able to achieve its goals of carbon peaking and carbon neutrality due in great part to its energy development plans. The research begins by comparing the underlying conditions of energy development in Northwest China. The paper next evaluates the level of fossil and sustainable energy sector clustering in Northwest China, revealing that the challenges involved with developing fossil and sustainable energy are dissimilar. Using the problems as a guide and the "energy revolution" promotion requirements and energy base construction as a foundation, the development of fossil energy in Northwest China must lengthen the industrial chain to improve the added value of products, and promote the synergistic and complementary development of the energy industry cycle, fossil energy, and sustainable energy. Optimizing the power transmission structure, capitalizing on the national power market reform, and promoting international energy cooperation are vital for fostering a sustainable energy sector.

Keywords: energy revolution; green-oriented transition; sustainable energy; fossil energy

JEL Classification: Q01; Q30; Q40

1. Introduction

Economic and social progress depend on energy. It generates most carbon emissions and fuels industrial growth. Carbon peaking during the 14th Five-Year Plan will lead to major energy sector adjustments. The new energy development effort must be founded on China's energy resource endowment, first formed and then broken, planned and step-by-step implementation of carbon peak action, in-depth promotion of the energy revolution, and improved clean and efficient use of coal. It must accelerate green transformation, conservation, and low-carbon industry growth. China's energy resources are "rich in the west and poor in the east" and "more coal, less oil, and poor gas." East and west energy demands differ structurally. East and central energy supplies are inferior to west ones, creating a supply-demand mismatch. However, China's energy-rich west is economically underdeveloped. This research begins with Western energy industry growth. It then assesses industrial agglomeration to identify industry development issues and produces policy suggestions that fulfill industrial development and "energy revolution" requirements. Based

on western China's energy resources, this study takes the rise of the energy sector as a reference, evaluates industrial development challenges through the lens of industrial agglomeration, and proposes policy proposals that fulfill industrial development norms and the "energy revolution."

1.1. Fossil Energy Resources Distribution in Five Northwestern Provinces

Northwest China's fossil energy resources mainly consist of coal and oil/gas. Coal reserves in Northwest China account for 33.11% of national total, with Xinjiang having 2.19 trillion tons of resources and 180.37 billion tons of reserves, ranking first. Shaanxi (176.338 billion tons), Gansu (165.6 billion tons) and Ningxia (172.111 billion tons, 31 billion pro) rank fourth, seventh and sixth respectively. Oil production is decreasing while natural gas is increasing. NW China's petroleum distribution is uneven. The government added 1.322 billion tons of proven geological petroleum reserves in 2020, up 17.7%. Northern Xinjiang's Junggar, Tarim, and Changji oil fields have 100 million tons of geological reserves.

There have been numerous studies in recent years on the energy resources of the five northwestern provinces of China. A study by Wang et al. (2019) investigated the distribution and characteristics of coal resources in the region, finding that coal-bearing strata in the region are mainly distributed in the Neogene and Quaternary systems. Zhang et al. (2019) conducted an analysis of the oil and gas resources in the region, finding that the region has large reserves of oil and gas, but that the resources are unevenly distributed. Yang et al. (2020) studied the petroleum resources of the region, concluding that the Junggar, Tarim, and Changji oil fields in northern Xinjiang have 100 million tons of geological reserves. A recent study by Li et al. (2021) focused on the natural gas resources in the region, finding that the region has abundant natural gas resources and that Shaanxi and Xinjiang are the major contributors to natural gas production in the region, accounting for 54.2% and 38.4% respectively.

Northwest China produced 66.59 million tons of oil in 2019, down 2.6% from 2018. Shaanxi decreased 3%. Northwest oil production reveals inequality. In 2019, Xinjiang produced 42.13%, Gansu 13.65%, and Qinghai 3.44% of the five Northwest provinces' oil. Shaanxi produced 40.68%. In 2020, China's natural gas sector added 30.0% more proven reserves, 105,1458 million cubic meters. Natural gas resources in Northwest China have been more concentrated in Shaanxi and Xinjiang over the last decade, with Shaanxi accounting for 54.2% of natural gas production in 2019 and Xinjiang accounting for 38.4%, while Gansu and Qinghai accounted for 0.17% and 7.2% of natural gas production, respectively.

1.2 Sustainable Energy in Northwest China

The development of sustainable energy sources in northwest China is critical to both economic growth and environmental protection. As the energy revolution continues to advance, researchers must identify effective strategies for developing renewable energy sources in the region. This section compares research on hydropower, wind, and solar resources in Northwest China and assesses their impact on energy sustainability.

Hydropower is a reliable and clean energy source that is widely used in Northwest China. To examine the development of hydropower in the region, Chen et al. (2020) studied hydropower development in the Yellow River basin, a major river in Northwest China. They found that hydropower is the largest source of renewable energy in the basin and accounted for 62% of the region's total energy production in 2017. Few and mostly concentrated in Qinghai, Northwest China's hydropower resources are growing slowly. The Yellow River Basin is crucial for the development and use of Northwest China's water resources, and Qinghai Province, the area with the highest hydropower resources there, has a potential reserve of 21.87 million kilowatts. Hydropower could be a major contributor to energy sustainability in the region if the impacts of hydropower are managed more effectively.

Wind energy is another important source of renewable energy in Northwest China. Gong et al. (2018) studied wind energy development in the region and found that wind power accounted for 8.2% of the region's energy production in 2016.Wind energy could provide a clean and cost-effective alternative to traditional energy sources. Wind energy resources are abundant in northwest China, but they are concentrated in the provinces of Xinjiang, Gansu, and Qinghai and are not distributed evenly. Figure 1 shows that Xinjiang has 23.61 million kilowatts of installed wind power, ranking first in Northwest China and accounting for 8.38% of the country, up 20.7% from 2019. The remaining four Northwest Chinese provinces, including Gansu, have installed wind power capacity according to their proportions.

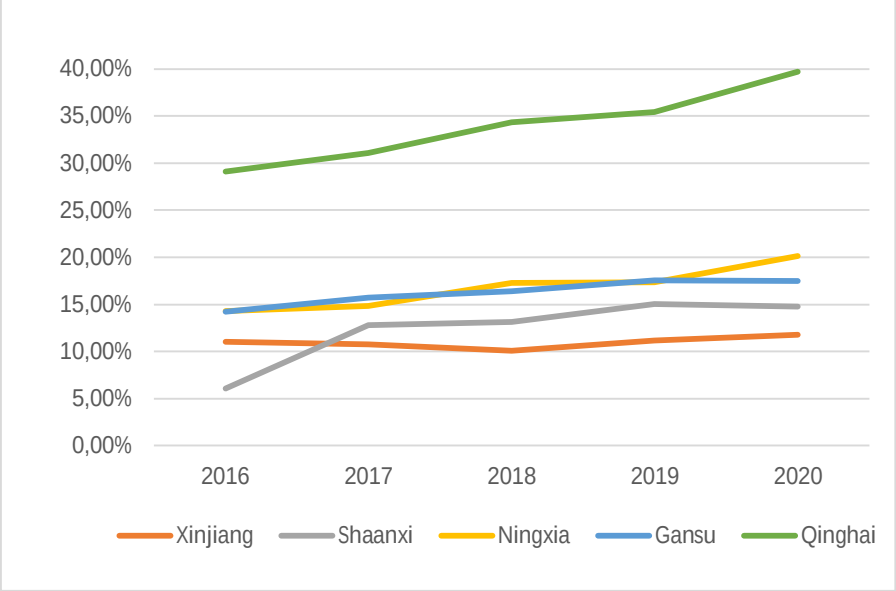

Figure 1. Northwest provinces installed solar power capacity accounted for the proportion of total installed capacity in each province trend

A lot of solar energy resources in the whole area of the five northwest provinces. Solar energy is becoming increasingly important for energy sustainability in Northwest China. Wang et al. (2019) studied the potential for solar energy development in the region and found that solar power could be a major contributor to energy production in the future.

The installed solar power capacity in Northwest China will rise between 2016 and 2020, as shown in Figure 2, and each province's share of the nation's installed capacity will

gradually rise as well. In 2020, Qinghai Province will have 16.01 million kilowatts of solar power capacity, up 42.7% from the year before. Xinjiang follows with 12.66 million kilowatts, up 18.2% from 2019. Qinghai Province generates 39.73 percent of its electricity from solar power. Ningxia follows with 20.14 percent of installed capacity from solar.

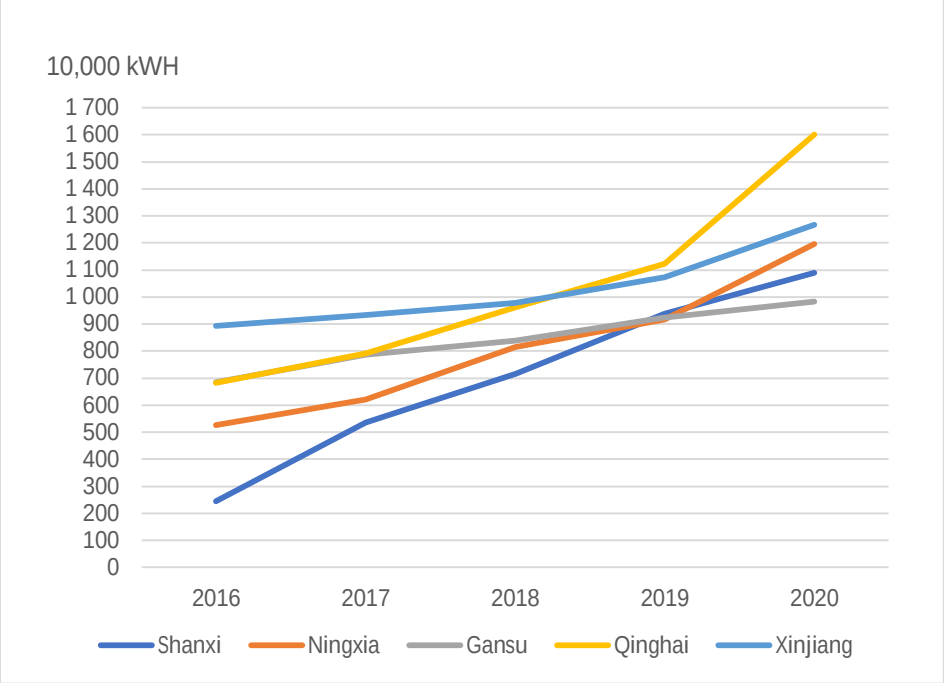

Figure 2. Installed wind power capacity by province in Northwest China, 2016-2020

In conclusion, hydropower, wind, and solar energy are all important sources of renewable energy in Northwest China. While hydropower is currently the region's largest source of energy production, other renewable energy sources such as wind and solar energy could also play a major role in the region's energy sustainability. To maximize the potential of these energy sources, a comprehensive policy framework and adequate investment in infrastructure should be implemented.

2. Methodology

2.1. Fossil Energy Industry Aggregation Level Measurement in Northwest China

This research uses locational entropy and spatial Gini coefficient investigations to create a spatial capacity agglomeration model to characterize Northwest China's fossil energy sector growth. This model shows each province's fossil energy clustering compared to national production.

$$EAD_i = \frac{EP_{ij}}{EP_i} / \frac{EP_j}{EP} \quad (1)$$

EAD_i represents the energy industry agglomeration of province *i*, EP_{ij} denotes the *i* province's fossil energy production, EP_i denotes the *i* province's total output value for that year, EP_j denotes the nation's total fossil energy production, and EP denotes the nation's total output energy value for that year. The production of standard coal is first converted in the

computation from coal, coke, and crude oil output; the conversion coefficients are displayed in Table 1. The years 2007 to 2018 were chosen as the sample period for this study based on the availability of data, and the data were taken from the China Statistical Yearbook, the statistical yearbooks of each province, and the China Energy Statistical Yearbook from 2008 to 2019.

Table 1. Fossil energy conversion factor for standard coal

	Coal	Coke	Crude Oil	Petrol	Gasoline	Diesel	Fuel oil	Gas
factor	0.7143	0.9714	1.4286	1.4714	1.4714	1.4571	1.4286	1.3300

2.2. Sustainable Energy Industry Aggregation Level Measurement in Northwest China

Locational entropy, also known as the local specialization rate or the specialization index, is a key indication of regional specialization that has been widely employed for centuries. It refers to the proportion of a region's total industries occupied by a certain industry compared to the proportion represented by domestic industries. Currently, it is also used to assess the degree of aggregation of a certain industry in a particular geographic region. The formula for its computation is as follows:

$$LQ = \frac{E_{ij}}{E_{i}} / \frac{E_{kj}}{E_{k}} \tag{2}$$

The economic significance of location entropy is the value of an industry's share in a particular region relative to its share in the economy as a whole. Where E_{ij} represents the total output value of industry j in nation or region i, E_i represents the total production value of region i, EP_{kj} represents the total output value of industry j in country or region k, and E_k represents the total output value of country or region k. In equation (2), the total production value may be determined by a variety of factors, including the number of firms, the value contributed, the income of the primary business, and the number of employees.

If the LQ value is less than 1, it indicates that the degree of specialization of industry j in region i is lower than or near to the national average and that there is no discernible aggregation tendency for industry j in region i. If the LQ value is larger than 1, it indicates that the degree of specialization of industry j in region i exceeds the national average. Within area i, there is a substantial concentration of industrial j. This indicator is created to indicate the clustering of industries within an area and the agglomeration at the regional and factor levels.

3. Results

3.1. Northwest China Fossil Energy Industry Agglomeration Results

The total standard coal production is then calculated using the conversion coefficient in accordance with the calculation formula for the industrial agglomeration measure specified in Section 3.2, after first obtaining the energy production statistics for each province in China from CAMAR. Following that, we determined the locational entropy of every province, and the results are displayed in Table 2.

Table 2. Fossil energy industry location entropy index

Province	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Growth Rate/%
Shanghai	0.20	0.21	0.19	0.59	0.61	0.64	0.70	0.20	0.22	0.22	0.22	0.20	0.34
Yunnan	1.42	1.39	1.02	0.84	0.77	0.69	0.70	0.63	0.64	0.61	0.64	0.71	-50.05
Neimenggu	4.25	4.93	5.37	0.74	0.81	0.78	1.06	7.04	6.92	7.27	9.35	9.93	133.84
Beijing	0.15	0.17	0.18	0.37	0.32	0.30	0.24	0.12	0.11	0.10	0.09	0.08	-45.36
Jilin	0.86	0.87	0.85	1.02	1.08	1.05	0.94	0.56	0.53	0.48	0.45	0.44	-48.59
Sichuan	0.80	0.74	0.67	0.39	0.40	0.37	0.36	0.47	0.43	0.44	0.36	0.28	-65.32
Tianjin	0.79	0.66	0.69	2.74	2.48	2.24	2.12	0.65	0.73	0.72	0.72	0.75	-4.85
Ningxia	3.33	3.21	3.83	1.59	1.25	2.30	2.56	4.56	4.44	4.34	4.57	4.42	32.87
Anhui	1.07	1.20	1.21	0.42	0.39	0.36	0.37	0.87	0.92	0.87	0.84	0.77	-28.07
Shandong	0.80	0.78	0.78	1.35	1.40	1.46	1.51	0.82	0.87	0.97	0.97	0.87	9.30
Shaanxi	9.19	8.27	7.89	3.50	3.43	3.23	3.39	9.78	10.85	10.66	10.00	10.29	11.94
Guangdong	0.16	0.17	0.17	0.54	0.52	0.53	0.55	0.17	0.19	0.20	0.19	0.20	26.19
Guangxi	0.17	0.13	0.13	0.32	0.63	0.76	0.75	0.31	0.30	0.31	0.36	0.34	108.74
Xinjiang	2.84	3.08	3.32	5.23	5.12	4.88	5.10	3.55	3.73	4.15	4.19	4.41	55.49
Jiangsu	0.20	0.19	0.18	0.37	0.40	0.41	0.43	0.18	0.19	0.19	0.17	0.15	-27.00
Jiangxi	0.54	0.54	0.49	0.53	0.50	0.50	0.49	0.37	0.33	0.31	0.23	0.20	-62.83
Hebei	0.90	0.84	0.87	1.37	1.50	1.55	1.45	0.73	0.80	0.80	0.74	0.74	-17.73
Henan	1.16	1.15	1.20	0.70	0.64	0.63	0.65	0.70	0.67	0.64	0.58	0.55	-52.24
Zhejiang	0.12	0.13	0.13	0.36	0.37	0.33	0.32	0.10	0.10	0.10	0.10	0.10	-20.58
Hainan	0.85	0.78	0.77	2.10	2.03	1.87	1.44	0.52	0.60	0.60	0.51	0.57	-33.44
Hubei	0.28	0.26	0.24	0.52	0.50	0.44	0.46	0.19	0.18	0.17	0.17	0.15	-46.40
Hunan	0.60	0.53	0.52	0.28	0.33	0.35	0.33	0.34	0.26	0.23	0.18	0.18	-69.31
Gansu	1.77	1.68	1.63	1.78	1.98	1.86	1.85	1.42	1.45	1.49	1.45	1.32	-25.42
Fujian	0.22	0.22	0.25	0.31	0.24	0.27	0.23	0.21	0.22	0.21	0.18	0.18	-17.23
Guizhou	3.01	2.77	3.14	0.59	0.51	0.56	0.52	2.51	2.23	2.23	1.98	1.67	-44.49
Liaoning	1.26	1.16	1.09	2.12	1.98	1.91	1.84	0.80	0.84	1.19	1.18	1.21	-4.07
Chongqing	0.73	0.70	0.60	0.17	0.17	0.14	0.13	0.36	0.32	0.23	0.13	0.13	-81.87
Shaanxi	3.76	3.59	4.10	3.31	3.35	3.59	3.56	4.69	4.95	5.16	5.30	5.36	42.52
Qinghai	1.61	1.72	1.60	1.81	1.92	1.97	1.90	1.47	0.88	1.03	1.14	1.07	-33.56
Heilongjiang	2.22	2.03	1.99	3.21	3.01	2.90	2.84	1.48	1.51	1.59	1.63	1.62	-27.08

According to Table 2, the five provinces with the highest level of fossil energy upstream industry concentration in 2007 were Shaanxi (9.19), Inner Mongolia (4.25), Shaanxi (3.76),

Ningxia (3.33), and Guizhou (3.01), and the five highest provinces in 2018 were Shaanxi (10.29), Inner Mongolia (9.93), Shaanxi (5.36), Ningxia (4.42), and Xinjiang (4.42), with little overall change. Simultaneously, China's fossil energy upstream business demonstrates a globally scattered and individually concentrated distribution. In 2018, all provinces have fossil energy upstream industry sites, with Shaanxi, Ningxia, and Xinjiang situated in the northwest among the top 5 provinces. Shaanxi (5.36), Ningxia (4.42), Xinjiang (4.42), Gansu (1.32), and Qinghai are the fossil energy industry agglomeration indices of the five northwest provinces in 2018. (1.07). In recent years, Qinghai and Gansu have dropped, keeping with the trend of robust growth of sustainable energy in Qinghai and Gansu; Xinjiang and Shaanxi have increased; and Ningxia has grown more moderate.

The concentration level of fossil energy upstream industries is decreasing nationwide. The falling areas are mostly in the Middle East, which matches China's low-carbon and green development goal. Some provinces are agglomerating more. The fossil energy sector agglomeration level in Xinjiang rose from 2.84 to 4.41, with a dynamic location entropy growth rate of 55.49%; Shaanxi Province rose from 3.76 to 5.36, with 42.52%; and Inner Mongolia grew from 4.26 to 9.93, ranking 1st in the country with 133.84%. The location entropy of the national fossil energy industry shows obvious geographical differences and gradually shifts from the eastern to the western regions in time, which is consistent with China's energy endowment and the "suppress the east, control the center, develop the west, and determine the industrial development pattern based on resource endowment, market location, environmental capacity, and other factors." This follows China's energy development policy of "restraining the east, managing the center, developing the west, and deciding the industrial growth pattern based on resource endowment, market location, environmental capacity, and other variables."

In conclusion, Northwest China's fossil energy industry remains vital and has grown. According to the above measurement results, the rising level of fossil energy industry agglomeration in Northwest China fully reflects that, around the strategic goal of energy revolution, China gives full play to the advantages of resource endowment in each region, takes advantage of Northwest China's fossil energy advantages, focuses on fossil energy industry development, and improves regional fossil energy industry levels. Since the above analysis of industrial agglomeration level is based on data related to the extraction industry in the upstream industry of fossil energy, the rise of industrial agglomeration level in some provinces in Northwest China actually reflects the expansion of the fossil energy extraction industry in Northwest China from the side. Northwest China's fossil energy extraction business is growing, reflecting the strategic objective of green and low-carbon.

3.2. Northwest Sustainable Energy Industry Agglomeration Index Results

The sustainable energy sector's location entropy index indicates the extent of industrial aggregation in each administrative region and its evolution. The dynamic location entropy index of the sustainable energy business can indicate the proportion of the sustainable energy industry in the region from both a temporal and spatial viewpoint, therefore reflecting the accumulation of sustainable energy in the region. The time view can more accurately describe

the pace of aggregation of the sustainable energy sector through time, while the geographical perspective can more accurately indicate the concentration of components. As the statistical index of the yearbook varies over the research period, the comprehensive comparison picks sustainable energy power generation rather than production index for assessment in terms of data accessibility and precision.

At this point in equation 2, E_{ij} represents sustainable energy generation in province i (expressed as total power generation minus thermal power generation and hydro power generation), E_i represents total power generation in province i, E_{kj} represents national sustainable energy generation, and E_j represents total national power generation in that year.

The sustainable energy sector's dynamic location entropy represents the rate of change of location entropy for this industry, which is also the rate of change of location entropy for the new energy industry, showing the rate of agglomeration development.

The dynamic locational entropy measurement results for each province in China from 2007 to 2019 may be calculated using equation (2), as shown in Table 3, and the ranking of the agglomeration level of the sustainable energy sector in each province is presented in Figure 3.

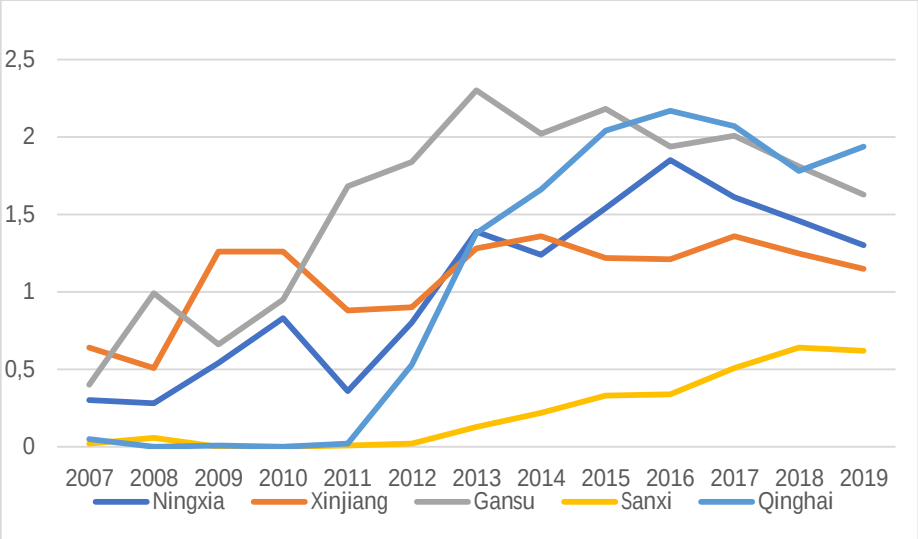

Figure 3. 2007-2019 sustainable energy industry aggregation levels in five northwest provinces

According to dynamic location entropy measurements, China's sustainable energy business exhibits regional agglomeration. The eastern coastal region has greater industrial agglomeration, and sustainable energy sectors are clustered in the east and west. Six of the top 10 provinces by sustainable energy industry agglomeration level in 2019 are eastern provinces, while the other four are western provinces with larger sustainable energy resource endowment.

In the northwest region, since 2007, the sustainable energy industry agglomeration index in Shaanxi has increased from 0.02 to 0.62, in Gansu from 0.4 to 1.63, in Qinghai from 0.05 to 1.94, in Ningxia from 0.3 to 1.3, and in Qinghai from 0.05 to 1.94. These provinces' sustainable energy industry all came from nothing and developed the agglomeration trend. The sustainable energy business is agglomerated in all Northwest provinces, albeit to different degrees. The 2019 measurement findings show that Qinghai has the highest agglomeration

Table 3. Sustainable energy industry aggregation level

Province	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Shanghai	0.17	0.26	0.42	0.35	0.08	0.09	0.16	0.12	0.10	0.10	0.19	0.24	0.23
Yunnan	0.02	0.92	0.00	0.09	0.19	0.35	0.43	0.48	0.56	0.79	0.76	0.67	0.65
Neimenggu	1.00	1.06	2.19	2.72	2.83	2.18	2.19	1.71	1.72	1.66	1.49	1.31	1.16
Beijing	0.00	0.00	0.21	0.29	0.30	0.26	0.21	0.14	0.11	0.11	0.15	0.13	0.13
Jilin	0.94	4.80	1.60	1.65	2.03	1.57	1.43	1.69	1.50	1.34	1.01	1.27	1.25
Sichuan	0.01	0.02	0.01	0.17	0.10	0.01	0.01	0.05	0.06	0.09	0.16	0.18	0.19
Tianjin	0.00	0.24	2.02	1.37	0.06	0.10	0.16	0.19	0.17	0.13	0.18	0.19	0.27
Ningxia	0.30	0.28	0.54	0.83	0.36	0.80	1.39	1.24	1.54	1.85	1.61	1.46	1.30
Anhui	0.00	0.01	0.08	0.09	0.12	0.09	0.08	0.32	0.18	0.29	0.41	0.48	0.46
Shandong	0.10	0.41	0.33	0.34	0.32	0.48	0.47	0.56	0.41	0.39	0.39	0.56	0.78
Shaanxi	0.01	0.07	0.06	0.13	0.09	0.41	0.40	0.48	0.53	0.64	0.75	0.82	0.80
Guangdong	4.96	3.05	3.83	3.40	3.12	3.07	2.72	2.46	2.39	2.17	1.95	1.80	1.86
Guangxi	0.23	1.19	0.60	0.35	0.01	0.09	0.05	0.40	0.07	1.05	1.07	1.05	1.02
Xinjiang	0.64	0.51	1.26	1.26	0.88	0.90	1.28	1.36	1.22	1.21	1.36	1.25	1.15
Jiangsu	1.58	1.45	1.79	1.55	1.38	1.18	1.00	1.06	0.82	0.73	0.74	0.89	0.99
Jiangxi	0.00	0.05	0.03	0.03	0.05	0.04	0.02	0.27	0.27	0.33	0.50	0.61	0.60
Hebei	0.20	1.65	0.53	0.84	1.18	1.49	1.33	1.26	1.14	1.08	1.09	1.08	1.15
Henan	0.00	1.45	0.14	0.10	0.15	0.14	0.06	0.14	0.09	0.14	0.24	0.39	0.50
Zhejiang	5.28	2.93	3.60	2.80	2.75	2.89	2.49	2.22	2.52	2.06	1.74	1.76	1.69
Hainan	0.12	0.07	0.14	0.41	0.49	0.30	0.57	0.46	0.75	2.87	2.77	2.32	2.58
Hubei	0.17	0.38	0.11	0.36	0.11	0.09	0.11	0.26	0.12	0.25	0.31	0.34	0.34
Hunan	0.00	0.00	0.00	0.00	0.14	0.26	0.11	0.34	0.32	0.35	0.39	0.45	0.49
Gansu	0.40	0.99	0.66	0.95	1.68	1.84	2.30	2.02	2.18	1.94	2.01	1.81	1.63
Fujian	0.12	0.23	0.35	0.24	0.37	0.38	1.29	1.64	2.62	2.76	2.87	2.52	2.15
Xizhang	2.97	4.26	2.52	1.74	1.72	2.08	1.76	1.50	1.29	0.75	1.07	1.09	1.21
Guizhou	0.00	0.00	0.00	0.01	0.00	0.13	0.18	0.16	0.31	0.35	0.38	0.36	0.34
Liaoning	0.24	0.29	0.47	1.00	1.49	1.53	2.11	2.41	2.40	2.24	2.19	2.15	2.04
Chongqing	0.07	0.03	0.05	0.05	0.19	0.54	0.06	0.15	0.05	0.08	0.12	0.11	0.14
Shaanxi	0.02	0.06	0.00	0.00	0.01	0.02	0.13	0.22	0.33	0.34	0.51	0.64	0.62
Qinghai	0.05	0.00	0.01	0.00	0.02	0.53	1.38	1.66	2.04	2.17	2.07	1.78	1.94
Heilongjiang	0.28	0.59	0.88	1.21	1.45	1.76	1.86	1.61	1.11	1.06	1.19	1.18	1.19

index at 1.94, followed by Gansu at 1.63, Ningxia at 1.3, Xinjiang at 1.15, and Shaanxi at 0.62. Qinghai's agglomeration index is three times that of Shaanxi, which comes last. This indicates that sustainable energy sector development varies by area.

4. Discussion

Significant energy transformation potential exists in China's Northwest, which could add to the country's efforts to switch to sustainable energy sources (Li et al., 2020). However, the development of the sustainable energy business in the region is not uniform, and some challenges remain to be resolved. The level of coal chemical industry processing and utilization must be improved (Zhang et al., 2018), the level of technology and management must be upgraded, and the length of the industrial chain must be expanded to ensure a better product added value. In addition, the abandoned wind and light rate of the five provinces in the Northwest region is still quite high and must be reduced by the construction of additional power transmission routes and by increasing interprovincial and interregional power transmission (Zhang et al.,2020). To reap the full benefits of the energy transformation plan, it is necessary to take actions tailored to the particular characteristics and circumstances of each location (Liu et al.,2019). To ensure the successful implementation of the energy transformation in Northwest China, it is also necessary to improve the greening of the energy structure, actively promote coal substitution and efficient utilization, improve the energy market mechanism, accelerate the transformation and upgrading of the energy industry, and increase investment in the development of new energy (Duani et al., 2020; Zeng & Wang, 2018; Cai et al., 2019).

5. Conclusions

This study discovered that specific agglomerations are produced by both fossil and alternative energy sources. On the one hand, Northwest China has a very rich resource endowment for fossil energy, while on the other, there is increasing pressure for energy conservation and emission reduction. On the other hand, although there is a trend toward clustering in the sustainable energy sector in Northwest China, there is still a significant disparity in the degree of clustering. The fossil energy industry in Northwest China has seen its issues with energy consumption, reliance, energy processing utilization, industrial chain extension, and industrial clean transformation exacerbated in the context of the energy revolution as a result of agglomeration. Due to the increasingly visible agglomeration, there are issues with the growth of the sustainable energy industry in the northwest provinces, such as significant disparities in industrial development trends and significant differences in consumption levels. As a result, Northwest China should use fossil fuels to improve the added value of products by lengthening the industrial supply chain, using technologies like carbon capture to achieve the circular development of the energy industry, and fostering the synergistic and complementary growth of the fossil fuel industry and clean energy. And we need to take the following actions for sustainable energy: 1. Make renewable energy foundations stronger. 2. Make the best possible use of the current channel while optimizing the power transmission structure. 3. Quicken the pace of the electricity market's

transformation; enhance the market's trading system. 4. provide top priority to global energy cooperation and boost capability for building renewable energy sources 5. Pay attention to geographic advantages; increase the peak regulation capability of the electricity infrastructure.

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Opportunities And Threats to the Development of Renewable Energy in Rural Areas in the Czech Republic and Poland

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Abstract: The Czech Republic and Poland face serious challenges related to the further development of renewable energy sources. It should be emphasized that a significant part of renewable energy sources (mainly except for photovoltaics) can be particularly easily implemented in rural areas. This is due to the dispersed development and the possibility of locating RES installations away from residential buildings. This may be particularly important in the case of biogas plants or large wind farms, which may be considered burdensome by some residents. It should be emphasized that both the Czech Republic and Poland do not fully exploit the potential of renewable energy sources in rural areas. The aim of the article is to determine the potential of rural areas in the Czech Republic and Poland to implement solutions based on renewable energy sources in the production of electricity and heat. The Foresight method was used during the research. The article also indicates the conditions related to the relief of energy transmission networks in connection with the reduction of the importance of large coal-fired power plants. It should be emphasized that the dispersion of energy generation sites will mean that energy will not have to be transmitted over very long distances.

Keywords: renewable energy sources; rural areas; economy; Czech Republic; Poland

JEL Classification: O11; Q28; Q56

1. Introduction

The development of renewable energy in rural areas in the Czech Republic and Poland is associated with the need to improve the quality of the environment and living conditions of the inhabitants, who are still exposed to frequent exceedances of the permissible concentrations of harmful substances in the air (Kůdela et al., 2020). An increase in the share of renewable energy is also a must, especially in the long run, when fossil energy resources will become scarce and their price will rise significantly (Olczak, 2022). Economic issues are also gaining importance due to the rising prices of CO_2 emission allowances. The Czech Republic and Poland face serious challenges related to the further development of renewable energy sources (RES). It should be emphasized that a significant part of renewable energy sources (mainly except for photovoltaics) can be particularly easily implemented in rural areas (Angowski et al., 2021; Luňáčková et al., 2017; Mik et al., 2021). This is due to the dispersed development and the possibility of locating RES installations away from residential buildings. This may be

particularly important in the case of biogas plants or large wind farms (Pommeret et al., 2017), which may be considered burdensome by some residents. It should be emphasized that both the Czech Republic and Poland do not fully exploit the potential of renewable energy sources in rural areas (Klepacki et al., 2021).

The implementation of ecological solutions in agriculture and industry is very important for the development of renewable energy in rural areas (Frantál & Prousek, 2016). The aim of the article is to determine the potential of rural areas in the Czech Republic and Poland to implement solutions based on renewable energy sources in the production of electricity and heat (Chu et al., 2022; Olczak et al., 2021). The article also indicates the conditions related to the relief of energy transmission networks in connection with the reduction of the importance of large coal-fired power plants (Raczkowski et al., 2022; Yan et al., 2021). It should be emphasized that the dispersion of energy generation sites will mean that energy will not have to be transmitted over very long distances. Moreover, the publication indicates the negative impact of energy generation by burning fossil fuels on the quality of life of the inhabitants and the environment (Mikhno et al., 2022).

It should be emphasized that in 2020 the share of renewable energy sources in Poland was lower than in the Czech Republic (Table 1). Although the Czech Republic and Poland in 2004 had a similar share of RES. It should be added that the share of RES to be achieved by the Czech Republic in 2020 was 13% of RES. In the case of Poland, however, it was 15% of RES in total energy production (Dzikuć & Tomaszewski, 2016).

Table 1. Share of energy from renewable sources (Eurostat, 2022)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
EU	9.6	10.2	10.8	11.7	12.6	13.9	14.4	14.5	16.0	16.7	17.4	17.8	18.0	18.4	19.1	19.9	22.1
Belgium	1.9	2.3	2.7	3.1	3.6	4.7	6.0	6.3	7.1	7.7	8.0	8.1	8.7	9.1	9.5	9.9	13.0
Bulgaria	9.2	9.2	9.4	9.1	10.3	12.0	13.9	14.2	15.8	18.9	18.0	18.3	18.8	18.7	20.6	21.5	23.3
Czechia	6.8	7.1	7.4	7.9	8.7	10.0	10.5	10.9	12.8	13.9	15.1	15.1	14.9	14.8	15.1	16.2	17.3
Denmark	14.8	16.0	16.3	17.7	18.5	19.9	21.9	23.4	25.5	27.2	29.3	30.5	31.7	34.4	35.2	37.0	31.6
Germany	6.2	7.2	8.5	10.0	10.1	10.9	11.7	12.5	13.5	13.8	14.4	14.9	14.9	15.5	16.7	17.3	19.3
Estonia	18.4	17.5	16.0	17.1	18.8	23.0	24.6	25.5	25.6	25.4	26.1	29.0	29.2	29.5	30.0	31.7	30.2
Ireland	2.4	2.8	3.1	3.5	4.0	5.2	5.8	6.6	7.0	7.5	8.5	9.1	9.2	10.5	10.9	12.0	16.2
Greece (p)	7.2	7.3	7.5	8.2	8.2	8.7	10.1	11.2	13.7	15.3	15.7	15.7	15.4	17.3	18.0	19.6	21.7
Spain	8.3	8.4	9.2	9.7	10.7	13.0	13.8	13.2	14.2	15.1	15.9	16.2	17.0	17.1	17.0	17.9	21.2
France	9.3	9.3	8.9	9.4	11.2	12.2	12.7	10.8	13.2	13.9	14.4	14.8	15.5	15.8	16.4	17.2	19.1
Croatia	23.4	23.7	22.7	22.2	22.0	23.6	25.1	25.4	26.8	28.0	27.8	29.0	28.3	27.3	28.0	28.5	31.0
Italy	6.3	7.5	8.3	9.8	11.5	12.8	13.0	12.9	15.4	16.7	17.1	17.5	17.4	18.3	17.8	18.2	20.4
Cyprus	3.1	3.1	3.3	4.0	5.1	5.9	6.2	6.2	7.1	8.4	9.1	9.9	9.8	10.5	13.9	13.8	16.9
Latvia	32.8	32.3	31.1	29.6	29.8	34.3	30.4	33.5	35.7	37.0	38.6	37.5	37.1	39.0	40.0	40.9	42.1
Lithuania	17.2	16.8	16.9	16.5	17.8	19.8	19.6	19.9	21.4	22.7	23.6	25.7	25.6	26.0	24.7	25.5	26.8
Luxembourg	0.9	1.4	1.5	2.7	2.8	2.9	2.9	2.9	3.1	3.5	4.5	5.0	5.4	6.2	8.9	7.0	11.7
Hungary	4.4	6.9	7.4	8.6	8.6	11.7	12.7	14.0	15.5	16.2	14.6	14.5	14.4	13.6	12.5	12.6	13.9
Malta	0.1	0.1	0.1	0.2	0.2	0.2	1.0	1.8	2.9	3.8	4.7	5.1	6.2	7.2	7.9	8.2	10.7
Netherlands	2.0	2.5	2.8	3.3	3.6	4.3	3.9	4.5	4.7	4.7	5.4	5.7	5.8	6.5	7.4	8.9	14.0
Austria	22.6	24.4	26.3	28.1	28.8	31.0	31.2	31.6	32.7	32.7	33.6	33.5	33.4	33.1	33.8	33.8	36.5
Poland	6.9	6.9	6.9	6.9	7.7	8.7	9.3	10.3	11.0	11.5	11.6	11.9	11.4	11.1	14.9	15.4	16.1
Portugal	19.2	19.5	20.8	21.9	22.9	24.4	24.1	24.6	24.6	25.7	29.5	30.5	30.9	30.6	30.2	30.6	34.0
Romania	16.8	17.6	17.1	18.2	20.2	22.2	22.8	21.7	22.8	23.9	24.8	24.8	25.0	24.5	23.9	24.3	24.5
Slovenia	18.4	19.8	18.4	19.7	18.6	20.8	21.1	20.9	21.6	23.2	22.5	22.9	22.0	21.7	21.4	22.0	25.0
Slovakia	6.4	6.4	6.6	7.8	7.7	9.4	9.1	10.3	10.5	10.1	11.7	12.9	12.0	11.5	11.9	16.9	17.3
Finland	29.2	28.8	30.0	29.6	31.1	31.0	32.2	32.5	34.2	36.6	38.6	39.2	38.9	40.9	41.2	42.7	43.8
Sweden	38.4	40.0	41.7	43.2	43.9	47.0	46.1	47.6	49.4	50.2	51.2	52.2	52.6	53.4	53.9	55.8	60.1

2. The Importance of Using Renewable Energy Sources in Rural Areas

Climate change, which is a frequent cause of the intensification of rapid atmospheric phenomena, contribute to huge losses associated with the repair of infrastructure, which is increasingly damaged as a result of, among others high winds. According to the report of the World Health Organization (WHO), which includes data from 2018, out of 50 cities in the

European Union with the highest concentration of PM2.5 suspended dust, as many as 36 are in Poland (Rokicki et al., 2022a). The problem of excessively polluted air does not only apply to cities (Simionescu et al., 2022). It is very common for rural areas (especially during the heating season) to have more polluted air than city centres (Zarębska & Dzikuć, 2013; Zaporozhets & Khaidurov, 2020). This is because in most large cities, combined heat and power plants operate, which must meet stringent ecological standards. In rural areas, however, solid fuel heating dominates in single-family buildings, which is often of poor quality (Olczak & Komorowska, 2021). On the other hand, heating installations are often based on energy-inefficient technologies that allow the combustion of fuels at relatively low temperatures, which contribute to excessive emissions of harmful substances into the air (Uğurlu, 2022).

It should be emphasized that the share of renewable energy sources in the total energy balance of Poland should increase in the coming years (Szumilas-Kowalczyk & Giedych, 2022). According to the National Plan for Energy and Climate for 2021-2030, Poland in 2030 should achieve a 21-23% share of renewable energy sources in gross final energy consumption. However, it should be expected that the future EU regulations will strive to significantly increase the share of renewable energy sources. Such a situation may result in the need to import renewable energy from other EU countries that will have a surplus of this energy. According to the estimates of the Supreme Audit Office, the costs of such an undertaking in Poland may amount to as much as PLN 8 billion. The relatively small share of renewable energy in Poland is caused, among others, by insufficient state support and the lack of stable and favorable legal solutions. Too small share of renewable energy sources in Poland could be caused, among others, by insufficient state support and the lack of stable and favourable legal solutions (Mazurek-Czarnecka et al., 2022).

It is worth noting that the prospect of increasing costs of coal-based energy (CO_2 fees) may contribute to the increased interest of renewable energy sources by Polish entrepreneurs, national authorities at various levels and individual energy consumers (Urban & Dzikuć, 2013), many of which live in rural areas that have greater potential for renewable energy development (Poór et al., 2015; Zhao et al., 2021). In rural areas there are more opportunities related to renewable energy production due to the difficulty of locating such investments as urban biogas plant or wind farm in urban areas (Piwowar & Dzikuć, 2013). Moreover, rural areas allow the production of large amounts of biomass (Aviso et al., 2020), which can be, among others, pyrolyzed or otherwise used during the production of energy based on renewable energy sources (Piersa et al., 2022; Saeed et al., 2022).

Broadly understood rural development in the Czech Republic and Poland is an important issue related to the quality of life of the inhabitants, which is also connected with ecological, economic and social aspects. Activities for economic development without caring for the environment in which man lives is not possible in the long run. Excessive use of natural resources over a longer period of time can lead to negative and irreversible effects that will significantly reduce the quality of life for future generations. It becomes necessary to take measures to reduce the negative impact of man on the environment.

It should be emphasized that bad air quality in Poland also occurs in rural areas due to excessive use of contaminated solid fuels for heating buildings using ecologically inefficient

technologies. Rural areas usually do not have access to district heating and a large part of rural areas lack access to natural gas, which is a more ecological fuel and is burned in boilers, which are usually characterized by higher energy efficiency than old-type coal boilers.

3. The Results of Research Using the Foresight Method

The share of renewable energy sources in Poland deviates from the standards of many countries, the so-called old EU (EU-15). The relatively low share of renewable energy sources in the total energy balance is one of the causes of poor air quality in Poland. The problem is not only large coal-based power plants that emit huge amounts of greenhouse gases (mainly CO_2), but also small installations for heating single-family buildings, a large part of which is located in rural areas. Low-grade fuel is often used in home boiler rooms, a large proportion of which do not meet the latest energy standards. As the project author's previous research shows, a significant percentage of Polish residents do not see the need to replace heating installations with more ecological ones. Poles also carry out investments to a lesser extent than residents of countries such as Germany, Belgium or Denmark. Support for renewable energy installations in rural areas will be a major challenge in the coming years. Without a real economic incentive, RES development in rural areas will be much less dynamic.

Analyzing the data of the European Environment Agency (EEA), it can be assumed that the air quality in the Czech Republic is better than in Poland. Although these are only estimates, the difference in values is so significant that it gives grounds to indicate the air quality in the Czech Republic as better. It is estimated that around 9,000 people died in the Czech Republic in 2018 due to poor air quality, which accounted for over 6% of all deaths in the country. In the same year, about 45,000 people died in Poland due to poor air quality, which accounted for over 12% of all deaths in the country (European Environment Agency, 2022).

The state authorities of the Czech Republic and Poland develop their own national RES development policies. In accordance with the assumptions of the National Plan for Energy and Climate, Poland plans to increase the maximum capacity of photovoltaic installations to approx. 7.3 GW in 2030. The national contribution to energy efficiency (primary and final energy consumption) of the Czech Republic and Poland should be assessed as insufficient (Table 2).

The Foresight method was used during the research. This method was be carried out among representatives of decision-makers (public authorities), industry, scientific circles and the media. Research on the future of various branches of the economy can also be conducted using foresight tools (methodologies). Foresight is an attempt to look into the future in a systematic way. This distinguishes foresight from natural script building in everyday life. Foresight covers a long period, with a time frame of up to 30 years. The research proposes to take a time interval of 10 years due to the significant dynamics of changes in the analysed sector (Szarucki et al., 2022). It should be emphasized that foresight should not be dominated by science and technology, but should also take into consideration socioeconomic factors that shape innovation. Foresight focuses on new, forward-looking technologies, for the development of which it is justified to support formal institutions. When conducting foresight, emphasis should also be placed on social aspects (the possibility of revitalizing the area in terms of its social adaptation).

Table 2. Objectives, targets and contributions under the Governance Regulation of countries of the Czech Republic and Poland (European Commission, 2022; European Union, 2018)

National targets and contributions	Countries	Latest available data	2020	2030	Assessment of 2030 ambition level
Binding target for greenhouse gas emissions compared to 2005 under the Effort Sharing Regulation (ESR) (%)	Czech Republic	4% (2018)	9%	-14%	As in ESR
	Poland	21%	14%	-7%	As in ESR
National target/contribution for renewable energy: share of energy from renewable sources in gross final consumption of energy (%)	Czech Republic	15% (2018)	13 %	22%	Unambitious (23% is the result of RES formula)
	Poland	11.3%	15%	21%-23%	Unambitious (25% is the result of the RES formula)
National contribution for energy efficiency: a) primary energy consumption (Mtoe) b) final energy consumption (Mtoe)	Czech Republic	a) 40.4 (2018) b) 25.3 (2018)	a) 43.3 b) 23.9	a) 41.43 b) 23.65	a) Low ambition b) Modest ambition
	Poland	a) 100.9 Mtoe b) 71.8 Mtoe	a) 96.4 Mtoe b) 71.6 Mtoe	a) 91.3 Mtoe b) 67.1 Mtoe	a) Modest b) Modest
Level of electricity interconnectivity (%)	Czech Republic	26.6% (2018)	29.6%	44.1%	N.A.
	Poland	4%	4%	8.7%	N.A.

In November and December 2022, Foresight surveys were conducted among representatives of energy sector companies, local governments, scientific communities and non-governmental organizations. The research involved 30 experts from Poland and the Czech Republic, who answered questions related to opportunities and threats to the development of RES in rural areas in the Czech Republic and Poland. Experts pointed out the most important problems and suggested possible solutions of developing renewable energy sources in rural areas.

According to the experts who participated in the research, the main barriers to renewable energy sources include: legal conditions, complex and often changing procedures for supporting investors, relatively high price of energy installations based on RES and old power grids. Old power grids often make it impossible to connect new RES-based installations due to the inability of power grids to receive electricity. The problem of old power grids, which hinders the development of renewable energy sources, is also noticed by

other researchers (Zou et al., 2021). As barriers to the development of renewable energy sources in rural areas, experts also indicated insufficient regulations in the field of implementing energy cooperatives, which could associate prosumers with renewable energy sources. Another problem is the insufficient development of small household energy storage facilities. The results of the analyzes carried out in the article are consistent with the results of research published by other scientists (Szymańska et al., 2022; Raczkowski et al., 2022; Rokicki et al., 2022b).

4. Conclusions

Research conducted using the Foresight method shows a significant potential for the development of renewable energy sources in rural areas. However, in order to increase the share of renewable energy sources in the total energy mix in the Czech Republic and Poland, it is necessary to consider to taking many actions. The most important of them include: implementation of solutions encouraging investors to build new installations based on RES.

Reducing existing barriers should also be considered, e.g. related to the ban on building wind farms at a distance from buildings of less than 10 times the height of a single installation (about 2 km). Moreover, it seems necessary to invest in transmission networks that will be able to receive more energy from prosumers. It is also important to create more favorable legal, economic and technical conditions for the use of energy storage facilities and the creation of energy cooperatives associating prosumers with RES-based installations. It should be noted that the development of renewable energy sources is particularly beneficial in rural areas, where less dense buildings make it possible to build installations that in cities could be a nuisance for neighbors, e.g. biogas plants or wind farms.

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Emotional Intelligence and Job Performance: Evidence from Albania Context

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Abstract: This paper reviews the correlation between emotional intelligence and job performance in 171 bank employees, in the city of Vlore, Albania. The correlation between emotional intelligence on employees' job performance was studied concentrating on four dimensions of emotional intelligence: self-awareness, self-management, self-motivation and social awareness. The questionnaire technique was used as one of the most frequent methods for data collection in empirical research. The data obtained from the questionnaires to investigate the conceptual model and the proposed hypotheses were empirically tested using the multiple linear regression model. The study was conducted between the June and December 2022. From the regression analysis, the emotional intelligence predicts employees' job performance. The analysis found that self-awareness and self-motivation factors have a positive impact on employee performance. The study shows that employees with high emotional intelligence have a positive impact on job performance. This study may contribute significantly by providing insight for banking sector in Albania. This sector should conduct trainings to increase the competences of employees, to understand the feelings and viewpoints of others, to show an active interest in their concerns, to recognize and fulfill the needs of customers, for the development of others and cultivating opportunities through diversity.

Keywords: emotional intelligence; job performance; banking sector; Albania

JEL Classification: M10; M14

1. Introduction

Emotional Intelligence and work performance have been and will continue to be discussed in different cultures. In Albania, there is still no study showing the connection between these two factors.

Emotional Intelligence is defined as a person's ability to perceive emotion in self and others, the intelligent use of emotions in the way individual improve behaviors and thoughts to achieve his/her goals (Goleman, 1998). People who know their own emotions and are good at reading the emotions of others can be more effective at their jobs. Emotional intelligence is very important in all service sectors, especially in banks, as they compete with undifferentiated products. Banking institutions are realizing that Emotional Intelligence is becoming more and more important as an element in increasing performance and in creating and maintaining healthy relationships in the workplace or outside of it. A bank's competitive advantage is achieved through quality services, improving its performance while simultaneously achieving market share, customer satisfaction, and loyalty, especially

in developing countries, such as Albania. The quality of the service can be affected as a result of the behavior of the employees, therefore high emotional intelligence is important in these financial institutions (Akhtar et al., 2017). Employees who know their own emotions and are good at reading the emotions of others can lead to better job performance.

Many studies have shown a positive relationship between emotional intelligence and the performance of employees in the service sector (Nel & De Villiers, 2004; Dhani & Sharma, 2018; Kumari & Priya, 2017).

The purpose of this paper is to see, through research and analysis, what impact emotional intelligence has in job performance in the banking sector. Normally, after defining the goal, the way we will achieve it is also important. The main objectives are to identify the main factors of emotional intelligence that affects the performance of employees' bank and to analyze the impact of emotional intelligence on the bank's performance efficiency.

2. Research Methodology

The methodology used is in function of the goal set in this study. The research is based on the literature review by many authors in the field of management. Most of the research articles and books are found in electronic libraries of scientific articles. Relying on a broad review of organizational behavior literature, the study builds the conceptual model and hypotheses. The questionnaire technique was used as one of the most frequent methods for data collection in empirical research. The data obtained from the questionnaires to investigate the conceptual model and the proposed hypotheses were empirically tested using the multiple linear regression model.

The survey was taken by 171 employees out of almost 240 employees in the banks of the city of Vlore. The study was conducted between the June and December 2022. The Statistical Package for Social Sciences (SPSS) was used to analyze the collected data.

The questionnaire was adapted from the researchers (Goleman, 2002; Bradberry & Greave, 2009; Pearce & Porter, 1986), which was used as an instrument for data collection. The measure emotional intelligence was evaluated by a scale developed by Goleman et al., (2002) and used by Bradberry and Greave (2009). This measure contains four items (self-awareness, self-management, self-motivation and social awareness) that were rated on a five-point scale (ranging from 1 strongly disagree, to 5 strongly agree), but a bit modified and adapted to this research. The emotional intelligence questionnaire consisted of 17 items and the job performance questionnaire consisted of 19 items. Job performance was assessed by a scale developed by Pearce and Porter (1986). This measure contains five items (general performance, ability to understand others, completion of tasks on time, quality of performance, and achievement of work goals) that were rated on a five-point scale (ranging from 1 strongly disagree, to 5 strongly agree). The data obtained from the questionnaires to investigate the proposed hypothesis are empirically tested using multiple linear regression.

3. Literature Review and Hypothesis

Empirical evidence shows that emotional intelligence has a significant positive relationship with employees' job performance (Nel & De Villiers, 2004; Dhani & Sharma,

2018; Kumari & Priya, 2017). Accordingly, this research studies the direct effect of emotional intelligence on job performance in the banking sector in the city of Vlore.

Before moving on to the discussion of the relationship between EI and employee job performance, we will define what emotional intelligence and job performance are. According to Emmerling and Goleman (2003) there are many definitions of EI, all aiming to understand the abilities and traits to recognize one's own emotions and those of others. Goleman (1998) says that emotional intelligence is about the ability to understand feelings, how to motivate ourselves to accomplish our tasks and be sensitive and able to handle relationships with others in the most effective way.

Job performance includes all work-related activities that help achieve organizational objectives (LePine et al., 2016). Work performance plays a very important role in the organization. It affects many personnel decisions such as promotion and employee retention, employee satisfaction and motivation. Goleman (2005) asserted that emotional intelligence increases employee performance and effectiveness.

Emotional intelligence is an important factor for improving employee performance, employee satisfaction, involvement and organizational commitment of employees (Danquah, 2014). Job performance should be positively related to employees' emotional intelligence because employees with high emotional intelligence are better able to assess and regulate their emotions leading to a higher sense of confidence and control, resulting in increased motivation to take proactive actions that lead to high performance (Wong & Law, 2002; Law et al., 2004). These reasons lead to our first hypothesis:

H1: Emotional intelligence is positive correlate with job performance in banking sector in Albania.

Goleman divides emotional intelligence into five components: self-awareness, self-regulation, self-motivation, empathy and social skill. "*Self-awareness is the extent to which individuals are aware of their own internal states (emotions, knowledge, physiological reactions) and their relation with others*" (Lawrence et al., 2018). Employees with a strong sense of self-esteem and skills improve employee performance (Noel, 2016). Self-awareness of emotional intelligence have a greater impact on employee' job performance (Mafuzah & Juraifa, 2016). Based on these arguments we present the following hypothesis:

H1a: Higher levels of self-awareness will affect in higher level job performance in the banking sector in Albania.

According to Goleman (1998), people with high self-management manage well their impulsive feelings and emotions, to remain calm in unhealthy situations, positive even in difficult moments, think clearly and are focused under the effect of pressure. This means that employees who manage their emotions tend to create better relationships with colleagues and this competence positively affects their performance. Jeyan (2006) concluded that self-control is higher in top and middle performers than low performers. Based on these arguments we present the following hypothesis:

H1b: Higher levels of self-management will affect in higher level job performance in the banking sector in Albania.

Goleman (1995) defined that emotional self-motivation involves the ability of controlling the emotional tendencies that facilitate in other to reach one's goals. Self-motivation also refers to the abilities to set goals and also to remain focused and positive by any setbacks that may occur during setting goals. According to Wolmarans and Martins (2016) self-motivation of emotional intelligence have a positive relation with job performance. Based on these arguments we present the following hypothesis:

H1a: Higher levels of self-motivation will affect in higher level job performance in the banking sector in Albania.

Social awareness is the employee's ability to understand the feelings and viewpoints of others, to show an active interest in their concerns, to recognize and fulfill the needs of customers. It is also the ability that the employee has for the development of others and the use of diversity. The study conducted by Noel (2016) showed that improving employees' social awareness leads to higher performance, improved collaboration between employees and ability to seek advice about their jobs. These arguments support the following hypothesis:

H1d: Social awareness will have a significant effect on job performance in the banking sector in Albania.

4. Data Analysis

This section reflects the statistical analysis which leads us towards the realization of the main goal of this study. The general demographic data of the respondents is treated, continuing with the analysis with the statistical model which serves to test the impact of emotional intelligence on job performance in the banking sector, city of Vlore.

4.1. General Demographic Data of Respondents

The findings of the general demographic information of the respondents were analyzed and divided into five categories which are: gender, age, educational level, marital status, and years of employment.

The gender analysis (Table 1) showed that 81.7% were female employees and 18.3% were male. From this analysis we can say that we are dealing with a gender imbalance in the respondents. The age analysis showed that the largest age category includes those aged 29-39, representing 46.5% of the total sample. The second group of respondents (32.4%) is between the ages of 18 and 28. While 40-50 years represents 19.7% and over 50 represents 1.4%. From this we can say that the employment of young people in banks is increasing.

Married respondents make up 70.4% of the total sample. The number of respondents who are single constitutes 28.2% of the total number of respondents. In analyzing the educational level, most of the respondents (78.9%) have a master's degree and respondents with a bachelor's degree are 18.3%. Regarding the years of employment of the employees in these companies, it results that: 35.2% of the employees were employed in less than 0-4 years, and 29.5% were employed for 5 to 14 years. While 15-20 years are 15.5% and over 20 years 19.7%.

Table 1. Demographic data (N = 171)

Categories	Distribution	Frequency	Percent
Gender	Female	140	81.7
	Male	31	18.3
Age	18-28 year	55	32.4
	29-39 year	80	46.5
	40-50 year	34	19.7
	Over 50 year	2	1.4
Level of education	Middle school	5	2.8
	Bachelor degree	31	18.3
	Master's degree	135	78.9
Civil status	married	120	70.4
	single	48	28.2
	divorced	3	1.4
Years of work in the organization	0-4 year	60	35.2
	5-14 year	50	29.5
	14-19 year	27	15.5
	over 20 years	34	19.7

4.2. Factor and Reliability Analysis for Emotional Intelligence Variables

The measure emotional intelligence was evaluated by a scale developed by Goleman et.al., (2002) and used by Bradberry and Greave (2009). This measure contains four items (self-awareness, self-management, self-motivation and social awareness) that were rated on a five-point scale (ranging from 1 strongly disagree, to 5 strongly. agree), but a bit modified and adapted to this research. To assess the reliability of the questionnaire, the Cronbach's Alpha coefficient was used, which resulted within the allowed values > 0.7.

In addition to the reliability coefficient, factorial analysis is also included in the analysis and explains the connection of the questionnaire units with the conceptual structure of the work that is required to be carried out. From the table generated through the SPSS data processing program, it can be seen that the Cronbach's Alpha coefficient for the emotional intelligence variables is 0.753, and the number of measurement units is 17, namely 4 units of self-awareness, self-management and self-motivation, and 5 units for social awareness (Table 2).

Table 2. Cronbach's Alpha coefficient results for emotional intelligence variables

IE factors	Nr	Cronbach's Alpha	Evaluation questions
Emotional Intelligence	171	0.753.	17
Self-awareness	171	745	4
Self-management	171	.845	4
Self-motivation	171	.782	4
Social awareness	171	.840	5

4.3. Factorial and Reliability Analysis for the Job Performance Variable

Job performance was assessed by a scale developed by Pearce and Porter (1986). This measure contains five items (general performance, ability to understand others, completion of tasks on time, quality of performance, and achievement of work goals) that were rated on a five-point scale (ranging from 1 strongly disagree, to 5 strongly. agree), but a bit modified and adapted to this research. Cronbach's alpha for this scale was 0.919, KMO .811 and the Bartlett Sphericity test .000 (Table 3), acceptable for continuing the analysis.

Table 3. Cronbach's Alpha, KMO and Bartlett's Test for job performance

Cronbach's Alpha		.919
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.811
Bartlett's Test of Sphericity	Approx. Chi-Square	736.725
	Df	120
	Sig.	.000

4.4. Multiple Linear Regression Analysis

In order to determine which of the emotional intelligence factors influence job performance, we performed a multiple regression analysis, where in this case we have job performance as a dependent variable and self-awareness, self-management, self-motivation and social awareness as an independent variable. Before we develop the regression model, which explains the relationship between the variables taken in the study, we see that there is a significant relationship between them for the 0.05 error level.

As Table 4 shows, the correlation between the independent variables "self-awareness", "self-management", "self-motivation", "social awareness" and the dependent variable "job performance" is respectively .533*, .286*, .567*, .477*.

Table 4. The correlation between the independent variables[1] and the dependent variable "job performance"

		Job Performance
Emotional Intelligence	Pearson Correlation	.523**
	Sig. (2-tailed)	.000
	N	171
Self-awareness	Pearson Correlation	.533**
	Sig. (2-tailed)	.000
	N	171
Self-management	Pearson Correlation	.286*
	Sig. (2-tailed)	.016
	N	171
Self-motivation	Pearson Correlation	.567**
	Sig. (2-tailed)	.000
	N	171
Social awareness	Pearson Correlation	.477*
	Sig. (2-tailed)	.000
	N	171

[1] "Emotional Intelligence", "self-awareness", "self-management", self-motivation", "social awareness"

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

We note that the relationship between the independent and dependent variables is positive. This shows the positive impact that emotional intelligence factors have on job performance. To assess whether the multiple regression model is valid or not, ANOVA analysis was undertaken. It is noted that the model raised is valid and the variables taken in the study explain 49.7% (adjusted R2 = 0.497) of the influence on the dependent variable job performance (Table 5). The constructed regression model is valid. In our model, the value F = 16.296 was significant at the 0.05 control level (because p = 0.000 is less than 0.05).

Table 5. ANOVA analysis for emotional intelligence variables and the impact on the variable "job performance"

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2,440.419	5	610.105	16.292	.000b
	Residual	2,471.524	165	37.447		
	Total	4,911.944	170			

a. Dependent Variable: job performance

b. Predictors: (Constant), self-awareness, self-management, self-motivation, empathy

In Table 6 of regression coefficients, we see that the factors "self-awareness" and "self-motivation" have acceptable p-values ($p < 0.05$).

Table 6. Coefficients of emotional intelligence variables and the impact on the variable "job performance"

		Coefficients					
		Unstandardized Coefficients		Standardized Coefficients			
Model		B	Std. Error	Beta	t	Sig.	
1	(Constant)	10.730	7.474		1.436	.156	
	Emotional Intelligence	1.124	.248	.401	2.298	.000	
	Self-awareness	1.147	.302	.406	3.797	.000	
	Self-management	-.491	.301	-.179	-1.633	.107	
	Self-motivation	1.194	.278	.428	4.298	.000	
	Social awareness	.514	.299	.187	1.721	.090	

a. Dependent Variable: job performance

The relationship between the independent and dependent variables is given by the regression equation:

$$\text{"Job performance"} = 10.730 + 0.428\ \text{"self-motivation"} + 0.406\ \text{"self-awareness"} + \\ + 0.401\ \text{“emotional intelligence”} \quad (1)$$

This means that hypotheses H1b and H1d are not accepted and hypotheses H1, H1a and H1c are accepted. This means that self-management and empathy do not have a significant positive effect on the job performance in the banking sector. The factors "self-awareness" and "self-motivation" have a significant positive effect on job performance in the banking sector. Self-motivation factor has more impact on job performance than self-awareness because the Beta coefficient is larger (.406) for self-motivation (Table 5).

5. Conclusions

From the multiple linear regression analysis, the results showed a positive effect of emotional intelligence on the success of employees at work. The study shows that there is a positive relationship between self-awareness and self-motivation and the performance of employees at work. From the study, the factor self-awareness of emotional intelligence is the best predictor of employees' job performance. The same conclusion has been reached by Butler et al. (2013) or Mafuzah and Juraifa (2016), It has been proven that individuals with a high level of self-awareness can take personal responsibility for their work, which positively affects work performance.

The results of the study are consistent with the findings of Wolmarans and Martins (2016), self-motivation of emotional intelligence have a positive relation with job performance. Employees' job performance is not related to social awareness and self-management as it showed a slightly weak relationship. This result is in contradiction with the findings of Mohamad and Jais (2016). Therefore, banks should pay more attention to increasing their employees' emotional intelligence skills to increase employee performance and achieve organizational goals.

6. Recommendations of the Study

Banks of the city of Vlore should conduct trainings to increase the competences of employees, to understand the feelings and viewpoints of others, to show an active interest in their concerns, to recognize and fulfill the needs of customers, for the development of others and cultivating opportunities through diversity.

Successful integration of self-awareness, self-management, social awareness, and self-motivation with job performance at work can lead to greater organizational achievement, success, productivity, employee improvement, well-being, and a healthy work environment.

7. Limits of the Study

There were several limitations in this study that limit the interpretation and application of the study findings. The aim of this study to explore the role of emotional intelligence in the performance of employees in the banking industry in the city of Vlore means that the findings are specific to this industry and cannot be generalized. Future research should be directed to the banking sector as well as other industries to gain more insight into the relationship between emotional intelligence and job performance.

Conflict of interest: none.

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The Economic Resilience Index in Pandemic Times: A Case Study for European Countries

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Abstract: The aim of this paper is to compare the economic resilience for 22 European countries for the years 2020 and 2021, and the related verification of important resilience factors. The paper is based on six indicators: i) fiscal surplus, ii) misery index, iii) year-on-year change in public debt, iv) digital economy and society index (DESI), v) trust in government policy, vi) net savings rate. The comparison is based on the economic resilience index (ERI), which is constructed by principal component analysis (PCA). The Nordic countries achieved the highest resilience: Norway, Denmark and Sweden, while the worst performers were Greece, Slovakia and Italy. The authors' conclusions that both the level of digitalization and trust in government policy can be considered important factors in terms of resilience were confirmed. Moreover, it was shown that there is a strong relationship between ERI and gross domestic product (GDP) per capita. Recommendations are made to invest more in digital infrastructure, to build trust in government policy, as well as to learn from each other, especially by exploring best practices, modifying them and applying them in selected economies.

Keywords: principal component analysis; regional resilience; macroeconomic policy; pandemic; economic resilience index

JEL Classification: C38; E62; O47

1. Introduction

The Covid-19 pandemic affected economies around the world when the disease began to spread from the Asian continent to the rest of the world, specifically China, in the spring of 2020. The reactions of individual countries were significant with global closures of local as well as international markets. There was a deep economic slump – almost without exception, 2020 will go down in history as a year of deep economic downturns in individual economies. However, the second half of the year, followed by 2021, was marked by a recovery and an effort to return to pre-pandemic levels as quickly as possible. The recovery of the economies from this extraordinary shock was not, or even could not, proceed without disparity. In this context, the apparent differences between countries or regions can be attributed to differences in the resilience of individual economies to economic and non-economic shocks.

This paper contributes to the existing literature by summarizing several relevant studies in the field of resilience, including a review of various statistical models and methods that can be used to measure regional resilience. Based on PCA, the ERI was constructed in the

analytical part, with the choice of variables based on the works of Briguglio et al. (2009) and Fišera (2022). Not only did this index reveal important components of resilience and clarify the relationships between the selected indicators, it also provided an international comparison across the selected countries. Finally, some modifications (extensions) of the index were discussed, as well as indicating possible interventions by economic policy makers leading to the strengthening of the economic resilience of regions in the future.

2. Theoretical Background

The concept of regional economic resilience has over time become an area of interest for many economists around the world. Even so, there are currently only a small number of definitions of economic resilience as a stand-alone concept (Modica & Reggiani, 2015). An interesting perspective on the issue of economic resilience is provided by Martin (2012), who adds adaptive resilience to the existing engineering and ecological resilience. Engineering resilience consists of the speed with which a system returns to an equilibrium state after a shock, ecological resilience is then characterized by the ability to find a new equilibrium state after a shock deflection, and finally adaptive resilience represents a form of reorganization of the system to minimize the impact of a given shock (Martin, 2012). In addition to Martin (2012), Christopherson et al. (2010) also point to the need to view regional resilience in the context of spatial economics, as regions are complex systems in which individual actors, institutions, space and time are dynamically interdependent elements. On the other hand, this very fact manifests itself in considerable difficulty in identifying of a new regional equilibrium (ecological resilience). It is not surprising, then, that most studies in the field of regional economic resilience lean more towards an engineering conception of resilience. Finally, a few definitions can be given, with Foster (2007) defining economic resilience as the ability of a region to anticipate, prepare for and respond to a shock and then recover from it. Rose and Krausmann (2013) note both the static and dynamic aspects of resilience as they argue that economic resilience is on the one hand the ability of a system to maintain its state in the event of a shock (static concept) and at the same time the speed of recovery from that shock (dynamic concept).

The current literature provides many studies that reflect on the choice of appropriate indicators or apply them directly to specific cases. The following table summarises several studies, including the choice of specific indicators, research methods and conclusions.

Based on Table 1, the choice of indicators, or the number of them, can be described as entirely subjective to the needs of the authors. Some limited their research to only one indicator (Martin, 2012; Di Caro, 2014), while Cutter et al. (2008), who developed a model for comparative assessment of resilience to natural disasters (DROP), based their research on as many as 29 indicators.

Particularly when examining resilience to economic shocks, (un)employment can be identified as a crucial indicator, which has been a key indicator in number of studies (Foster, 2007; Cutter et al., 2008; Briguglio et al., 2009; Davies, 2011; Martin, 2012; Di Caro, 2014; Kitsos & Bishop, 2018). In terms of changes in (un)employment, both Martin (2012) and Davies (2011) reached the same conclusions – industrial regions are less resilient to shocks.

Table 1. Literature review of resilience

authors	regions	indicators	methods	conclusions
Foster (2007)	Buffalo-Niagara Falls MA (1970-2000)	change in employment, population change, per capita income, poverty	economic indexes	weak resistance of the investigated region to metropolitan regions, resistance as a four-phase cycle
Cardona et al. (2008)	14 countries in America (2000)	insurance and collateral payments, disaster reserve fund, donations, new taxes, budget reallocation, external loans, international reserves	disaster deficit index	creation of an index that examines the fiscal position and potential loss of countries in the Americas, particularly in the event of extreme disasters
Cutter et al. (2008)	natural disasters	quality of life, transport network, municipal income, wealth creation, demography, employment, etc. (29)	DROP model (composite index)	creation of a model for comparative assessment of resistance to natural disasters
Briguglio et al. (2009)	86 countries	inflation and unemployment, interest rates, external debt, education, fiscal deficit, etc. (13)	composite index, regression analysis	countries' performance is related to their vulnerability and resilience, the resilience index is highly correlated with GDP per capita
Davies (2011)	regions in Europe (2008-2010)	unemployment, GDP per capita, population density, government intervention (business support)	regression and correlation analysis, semi-structured interviews	higher impact of unemployment growth on industrial regions, importance of government support
Martin (2012)	UK regions (1970-2010)	employment	economic indexes	high impact of recession on industrial regions, their low recovery and structural changes
Graziano & Rizzi (2013)	Italian provinces (2007-2011)	bank deposits, loans to companies, total consumption, income per capita (19)	factor analysis (PCA)	higher economic, social and environmental resilience of northern Italian provinces,
Di Caro (2014)	Italian regions (1970-2010)	employment	SUR model, vector error correction model	higher resistance of the northern Italian regions in terms of engineering and ecological resistance
Kitsos & Bishop (2018)	local authority districts of Great Britain (2004-2014)	employment, population density, education, specialization (18)	correlation analysis, linear regression models	higher losses in regions with higher employment rates, especially in the north of the country
Xie et al. (2018)	earthquake in Weunchan (2008-2011)	loss of GDP, sectoral property damage, government investment in recovery	dynamic computable general equilibrium (CGE model)	resilience strategies could significantly reduce GDP losses from 2008-2011 by nearly 50%, the importance of investment in recovery

The evidence came from both Martin (2012), who focused only on UK regions between 1970 and 2010, and Davies (2011), who focused on a few European regions over a much narrower period (2008-2010), i.e. during the financial crisis. Based on these studies, the clear conclusion is that regional policy attention should be primarily focused on regions where there is a higher concentration of manufacturing industry.

The difference at the local scale is noted at the level of Italian regions by Graziano and Rizzi (2013) and Di Caro (2014), who point to significant differences in the resilience of northern and southern regions. Although the northern part of Italy has a smaller population than the south, in the long run the regions in this area have higher GDP per capita. Briguglio et al. (2009) also highlighted the importance of this indicator as an important indicator of regional resilience. Graziano and Rizzi (2013), using PCA, constructed indexes that fully demonstrated that northern Italian regions have higher resilience in the long run, and moreover in all areas of sustainable development (economic, social and environmental).

3. Data and Methodology

For the construction of the index, data for 22 selected countries were collected from the OECD, Eurostat and the European Commission's websites for the years 2020 and 2021, by taking the average of these two years. The selection of countries was made according to the availability of data for each indicator, namely: i) fiscal surplus (in % of GDP), ii) misery index (in %), iii) year-on-year change in public debt (in % of GDP), iv) digital economy and society index (DESI, 0-100), v) trust in government policy (in %), vi) net savings rate (in % of GDP).

3.1. Selection of Indicators and Hypothesis

The first trio of indicators is based on the work of Briguglio et al. (2009), who constructed a resilience index for 86 different countries. This index was based on four core areas (macroeconomic stability, microeconomic stability, good governance and social development), and for the purposes of this paper only the macroeconomic stability dimension was considered. However, there is some modification compared to this study – instead of fiscal deficit, fiscal surplus is considered, misery index is modified and expanded to include real economic growth, and instead of external public debt, year-on-year change in public debt to GDP is considered. The misery index is expanded by real economic growth to better reflect the state of the economy and, as in the previous case, the reverse is considered, i.e. the sum of unemployment and inflation is subtracted from economic growth. Finally, the level of external public debt has been replaced by the dynamics of the reduction of public debt to GDP, with the same purpose that a positive value determines the desired state – a reduction of public debt.

Based on the conclusions of Fišera (2022), DESI was considered as an additional indicator to reflect the digital maturity of EU countries. The author is of the opinion that higher investment in digital infrastructure will allow to better withstand similar shocks in the future. For some countries in particular, Sweden being a case in point, it has been shown that trust in government policy can be an important metric, not only in times when society has been called upon to comply with epidemic measures, but especially in times of rising debt, when

understanding in the event of higher taxation or reduced public spending will be important. The inclusion of these 'new' indicators leads to the following hypothesis:

- H_1: Digitalization and trust in government policy are important resilience factors.

The last indicator relates to the potential of the economy, particularly in the recovery phase, namely the net savings-to-GDP ratio. This indicator was chosen because savings play a key role in the economy and their level significantly affects future consumption and investment activity.

Furthermore, as Briguglio et al. (2009) have shown, the resilience index is positively correlated with GDP per capita, so this hypothesis is also tested here beyond the construction of the index:

- H_2: There is a significant relationship between the resilience index and GDP per capita.

3.2. Principal Component Analysis

The economic resilience index was constructed through PCA, like Graziano and Rizzi (2013). This multivariate statistical method aims to transform the original number of variables into a lower number of new variables, called components, which have more appropriate properties than the original variables – they are lower in number, explain almost all of the original variability, are uncorrelated with each other and are a linear combination of the original variables (Karamizadeh et al., 2013). The method is based on a source data matrix where the rows represent *n* objects and the columns represent *p* features (variables). The source matrix has the form:

$$\boldsymbol{X}(n\ x\ p) = \begin{bmatrix} X_{11} & \cdots & X_{1p} \\ \vdots & \ddots & \vdots \\ X_{n1} & \cdots & X_{np} \end{bmatrix} \quad (1)$$

The essence of this method is the approximation of a source data matrix *X* containing *n* measurements for *p** principal components. Typically, a correlation matrix is first constructed by examining the correlation between the variables based on the respective correlation coefficients r_{jk} (for j, k = 1, ..., p), which can take the values $-1 \leq r_{jk} \leq 1$:

$$(p\ x\ p) = \begin{bmatrix} 1 & \cdots & r_{1p} \\ \vdots & \ddots & \vdots \\ r_{p1} & \cdots & 1 \end{bmatrix} \quad (2)$$

In the next step, it is recommended to use two tests – the Kaiser-Meyer-Olkin test designed to check whether the application of PCA to the data set makes sense, and the Bartlett's test to check for homoskedasticity, i.e. whether all random variables have the same finite variance. The first test follows the so-called Kaiser-Meyer-Olkin criterion, which can take values between 0 and 1:

$$KMO = \frac{\sum\sum_{j\neq k} r_{jk}^2}{\sum\sum_{j\neq k} r_{jk}^2 + \sum\sum_{j\neq k} p_{jk}^2} \quad (3)$$

where r_{jk} are the relevant correlations (see equation 2) and p_{jk} define the so-called partial correlations. The value of this criterion should be at least 0.5, otherwise the use of this method cannot be considered acceptable. The Bartlett's test is based on the following equation:

$$K\chi^2 = \frac{(N-k)\,ln\left(S_p^2\right) - \sum_{i=1}^{k}(n_i-1)ln\left(S_p^2\right)}{1 + \frac{1}{3(k-1)}\left(\sum_{i=1}^{k}\left(\frac{1}{n_i-1}\right) - \frac{1}{N-k}\right)} \tag{4}$$

where $N = \sum_{i=1}^{k} n_i$ a $S_p^2 = \frac{1}{N-k}\sum_i (n_i-1)S_i^2$ are the pooled variance estimates. This test has approximately a χ_{k-1}^2 distribution. The null hypothesis is rejected if $\chi^2 > \chi_{k-1,\alpha}^2$. If the null hypothesis is rejected, the data must be standardized. Standardization occurs even if the random variables are expressed in different units. Standardization is determined by the following equation:

$$\begin{aligned} Z_1 &= \frac{(X_1 - \mu_1)}{\sqrt{\sigma_{11}}} \\ &\vdots \\ Z_p &= \frac{(X_1 - \mu_1)}{\sqrt{\sigma_{pp}}} \end{aligned} \tag{5}$$

where μ is the vector of means and σ is the corresponding standard deviation. The standardization of the original variables can also be written in matrix form:

$$Z = (V^{\frac{1}{2}})^{-1}\,(X - \mu) \tag{6}$$

Where

$$V^{\frac{1}{2}}(p\ x\ p) = \begin{bmatrix} \sqrt{\sigma_{11}} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \sqrt{\sigma_{pp}} \end{bmatrix} \tag{7}$$

For the i-th principal component obtained as a linear combination of standardized variables:

$$Y_i = \omega_i^T z = \omega_1^T\,(V^{\frac{1}{2}})^{-1}\,(X - \mu) \tag{8}$$

where ω represents the eigenvectors. These determine the weight of each of the principal components. The principal components are ordered such that the first component (PC_1) explains the largest variability in the original data. Further, the following components are uncorrelated with the previous components. As for the appropriate number of principal components, this choice depends to some extent on the subjective view of the author. However, Kaiser (1960) recommends number of principal components for which the eigenvalue is at least 1. A more detailed description and construction of PCA is developed in Johnson and Wichern (2007).

Mathematical and statistical calculations in the application of this method were performed exclusively in STATISTICA 12, SPSS and Microsoft EXCEL software.

4. Results

A sample correlation matrix was first constructed from a matrix of original data averaged over 2020 and 2021 across the indicators (see Table 2).

Table 2. Correlation matrix

indicators	DESI	trust in government	net savings rate	fiscal surplus	misery index	reduction of public debt
DESI	1					
trust in government	0.80	1				
net savings rate	0.70	0.54	1			
fiscal surplus	0.68	0.66	0.72	1		
misery index	0.34	0.29	0.61	0.52	1	
reduction of public debt	0.02	0.23	-0.14	0.05	-0.05	1

The correlation matrix shows significant relationships between the variables, and a correlation of at least 0.5 can be considered a relevant relationship. Net savings rate (0.72), DESI (0.68) and trust in government (0.66) are the most strongly correlated with this indicator.

The next step tested the significance of applying PCA to the original dataset or checking the agreement of variances for possible data standardization.

Table 3. Assessing the suitability of applying PCA and testing for homoscedasticity

The Kaiser Meyer Olkin test	Bartlett's test	
0.750	value of the testing criteria	61.624
	p-value	0.000

Table 3 shows the results of The Kaiser Meyer Olkin test when the use of PCA was recommended, as the value of 0.750 was well above the allowable limit of 0.5. As for the Bartlett's test, the null hypothesis of agreement of variances was rejected at any level of significance, as shown by the null p-value (for the purpose of this paper, a standard *p*-value of 0.05 was considered). Before the necessary standardization, the principal components were determined based on the eigenvalue (see Table 4).

Table 4. Eigenvalues of the principal components

components	eigenvalues	the % of overall variance	cumulative share in %
1	3.379	56.310	56.310
2	1.154	19.233	75.542
3	0.759	12.656	88.198
4	0.298	4.965	93.163
5	0.268	4.463	97.626
6	0.142	2.374	100.000

The first two principal components reach an eigenvalue greater than 1, with the former explaining more than half of the original variability in the data (56.310%) and the latter 19.233%, cumulatively explaining 75.542% of the original variability. From the point of view of further progress, this proportion can be found to be sufficient.

Table 5. Standardized correlation matrix of indicators and components

indicators	comp_1	comp_2	comp_3	comp_4	comp_5	comp_6
DESI	0.475	0.106	-0.393	0.299	0.234	0.681
trust in government	0.445	0.350	-0.292	0.356	-0.407	-0.550
net savings rate	0.473	-0.254	0.066	-0.144	0.707	-0.431
fiscal surplus	0.480	0.001	0.035	-0.771	-0.386	0.157
misery index	0.349	-0.314	0.733	0.402	-0.249	0.137
reduction of public debt	0.028	0.839	0.466	-0.079	0.262	0.063

Table 5 already presents a standardized matrix of indicators and principal components. Attention has been focused exclusively on the first two components. For the first component, we can observe more significant positive relationships approaching 0.5 for DESI (0.475), trust in government (0.445), net savings rate (0.473), fiscal surplus (0.480) and already slightly more distant misery index (0.349). However, there is no doubt that this component is affected by these indicators in a positive sense, as evidenced by the positive values. The remaining indicator (reduction of public debt) is explained by the second component (0.839), again in a positive sense. Based on these findings, the Economic Resilience Index (ERI) can be calculated using the following equation:

$$ERI = 0.563 \cdot COMP\_1 + 0.192 \cdot COMP\_2 \quad (9)$$

The Economic Resilience Index was determined sequentially for all 22 selected countries, with index values ranging between -0.88 and 1.26 (see Appendix). It is true that a larger value within the index indicates a higher resilience of a country to the Covid-19 pandemic for the years 2020 and 2021.

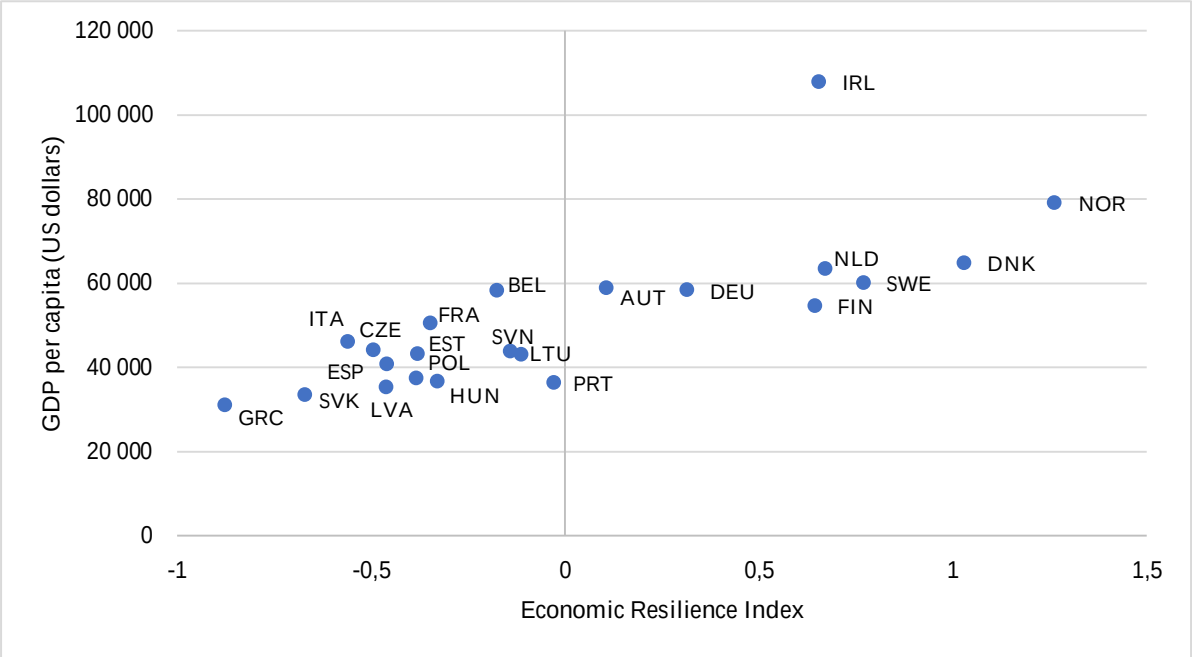

Figure 1. GDP per capita in 2021 and Economic Resilience Index (own processing based on OECD (2022))

The ERI values were then used in a regression analysis with GDP per capita to test the hypothesis of whether a significant relationship can be seen between regional resilience and this important macroeconomic indicator.

Figure 1 clearly shows that there is a strong relationship between ERI and GDP per capita, with countries with higher GDP per capita generally also achieve higher ERI values. Despite the outlier for Ireland, the correlation between the indicators reaches 0.767, which explains the relatively strong correlation.

5. Discussion

There is no disputing that the Covid-19 pandemic was an unexpected shock that caused significant losses to economies around the world. On the other hand, there have been significant differences between countries in terms of their economic downturn and their now gradual return to their pre-pandemic trajectory. The ERI values constructed in this study clearly show which countries, based on selected indicators, have performed more resiliently over 2020 and 2021, and conversely which countries have experienced greater economic downturns. The highest ERI values are generally achieved by the Nordic countries, namely Norway (1.26), Denmark (1.03), Sweden (0.77). In contrast, the least resilient countries are Greece (-0.88), Slovakia (-0.67) and Italy (-0.56), and others (see Appendix).

The correlation analysis showed a significant relationship between fiscal surplus (deficit) and trust in government policy as well as the level of digitalization (DESI), satisfying the first hypothesis H1. At the same time, the findings of Fišera (2022) that countries with higher levels of digitalization and higher trust in government policy were more resilient in times of pandemics were confirmed. Countries such as Norway, Denmark and Sweden can be characterized as digitally advanced countries with high trust in government policy, which is undoubtedly reflected in the low deficits or even surpluses in public finances in recent years. Of course, more detailed conclusions would require deeper investigation into the actual setup of the processes taking place in these economies.

The Economic Resilience Index constructed in this study through PCA was able to explain more than 75% of the original data variability across countries and variables in 2020 and 2021 using only 2 principal components. In addition, a positive correlation between ERI and GDP per capita was confirmed across countries (Figure 1), thus satisfying the second hypothesis H2. It should be added that although different crises were assessed - the financial crisis examined in Briguglio et al. (2009) and Covid-19 in this study - and a different set of indicators were partly chosen, the relationship between resilience and GDP per capita remained.

In future research, it would be useful to extend the conclusions drawn to a longer time horizon, e.g. to include the period between the financial and pandemic crises. The fact that economies are still recovering from the pandemic and are currently facing an energy crisis and other negative effects also leads to considerations of a longer time horizon. There are also suggestions to expand the ERI to include other dimensions of resilience, such as social and environmental, which Graziano and Rizzi (2013) have previously included in their studies. A larger number of indicators would allow for a more comprehensive view of country resilience in the future. Furthermore, the possibility of removing outliers can be discussed.

6. Conclusions

The aim of this paper was to compare the resilience of 22 European countries for the years 2020 and 2021 and to test two related hypotheses. The Economic Resilience Index allowed a comparison of individual European countries in terms of their resilience in a pandemic. It showed that the Nordic countries are outperforming the rest of Europe on this measure, which should evoke an increased interest in examining economic policies in these countries and then applying proven principles and processes, of course, taking into account the limits and differences between countries. Clearly, economic policy makers should conclude the increasing importance of investment in digital infrastructure as well as the much more difficult task of building greater trust in government policy, both of which have been shown in this study to have a significant impact on country resilience. In addition, a strong positive correlation between resilience and GDP per capita has been demonstrated, with better performing economies better able to absorb shocks and more easily bounce back. Finally, in applying the index, it was recommended to consider including a longer time horizon, a higher number of indicators, expanding the index to include social and environmental dimensions, or eliminating outliers.

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Conflict of interest: none.

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Appendix

Table A1. Average Values of Variables for Selected Countries (2020, 2021), Economic Resilience Index

country	DESI	trust in government	net savings rate	fiscal surplus	misery index	reduction of public debt	ERI	rank
Austria	55.60	61.84	8.73	-6.97	-9.14	-0.08	0.10	8
Belgium	56.20	38.40	6.12	-7.27	-7.25	-0.06	-0.18	12
Czech Republic	49.10	30.17	5.75	-5.44	-7.18	-0.19	-0.50	19
Denmark	69.60	68.38	14.21	1.92	-5.05	-0.06	1.03	2
Estonia	60.40	49.21	12.25	-3.94	-4.80	-0.57	-0.38	15
Finland	69.70	76.12	5.97	-4.11	-8.54	-0.06	0.64	6
France	51.40	42.20	3.16	-7.76	-9.56	-0.08	-0.35	14
Germany	55.10	62.95	10.44	-4.03	-6.18	-0.08	0.31	7
Greece	37.30	39.96	-6.82	-8.69	-16.54	-0.04	-0.88	22
Hungary	44.35	42.27	8.94	-7.34	-7.01	-0.09	-0.33	13
Ireland	61.05	60.58	10.34	-3.35	2.43	0.02	0.65	5
Italy	44.55	36.44	3.53	-8.36	-11.50	-0.07	-0.56	20
Latvia	50.10	30.07	1.29	-5.66	-8.63	-0.10	-0.46	18
Lithuania	52.85	38.89	8.51	-4.01	-7.76	-0.12	-0.12	10
Netherlands	66.40	68.27	10.47	-3.16	-6.01	-0.05	0.67	4
Norway	66.35	80.14	16.65	3.65	-5.39	-0.04	1.26	1
Poland	43.00	26.62	9.10	-4.38	-5.15	-0.10	-0.38	16
Portugal	49.70	59.55	-0.97	-4.36	-8.88	-0.05	-0.03	9
Slovak Republic	44.20	26.16	1.78	-5.41	-9.49	-0.15	-0.67	21
Slovenia	52.00	39.61	7.95	-6.20	-3.86	-0.08	-0.14	11
Spain	57.45	37.68	4.16	-8.50	-19.45	-0.11	-0.46	17
Sweden	67.90	65.23	13.63	-1.43	-8.75	-0.05	0.77	3

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Do Area-based Partnerships Favour the Development of Short Food Supply Chains? Analysis of Local Product Offers on the Websites of Local Action Groups in Two Regions of Poland

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Abstract: Local Action Groups (LAGs) are cross-sectoral, area-based partnerships of local stakeholders working for social and economic development in functional regions. Their main task is to redistribute public aid funds as part of grant competitions for grassroots initiatives of local social organizations, farmers, entrepreneurs and local government institutions. LAGs can also play an important role in developing local food markets. The main aim of this research was to establish the extent to which LAGs promote local food products related to short food supply chains through their home websites. The authors have analyzed the websites of LAGs from two regions of Poland: Lower Silesia and Lesser Poland in an attempt to establish whether they contain permanently posted content related to offering and promoting local products (including traditional ones). Research has shown that almost half of all LAGs surveyed (47%) do not promote local products on their websites. However, examples of good practices indicate that they have the potential to carry out such tasks.

Keywords: area-based partnerships; local and traditional product promotion; short food supply chains; website content analysis

JEL Classification: Q18; P25; D71

1. Introduction

Cross-sectoral territorial partnerships referred to as Local Action Groups (hereinafter: LAGs) support the socio-economic development and activity of inhabitants in functional rural and fishing regions (Biczkowski, 2020; Furmankiewicz et al., 2021a; Moseley, 2003; Phillipson & Symes, 2015), as well as in cities and urban districts (Panciszko, 2020; Servillo & De Bruijn, 2018). The idea has been developed in the European Union (EU) since the 1990s (Barke & Newton, 1994; Lacquement et al., 2020), while in Poland they began to be established after the state's accession to the EU in 2004, initially as part of the LEADER+ Pilot Programme (Furmankiewicz et al., 2015; Zajda, 2014). According to Polish law, LAGs constitute a legal form of association. Within their ranks, residents, representatives of social organizations, local companies, local governments and other institutions are responsible for the preparation of territorial development strategies. After their approval, LAGs receive EU funds for the organization of local grant competitions for farmers, entrepreneurs, social organizations and

public institutions, as part of Community-Led Local Development (hereinafter: CLLD) (Furmankiewicz et al., 2021b; Rodriguez et al., 2019; Servillo & De Bruijn, 2018). Financial support under the CLLD may be obtained, among others, for projects by local stakeholders in the field of small processing, networking in the field of creating short supply chains and local markets, as well as promotional and marketing activities (Ministerstwo Infrastruktury i Rozwoju, 2014). Also, LAGs as associations can undertake their own activities and implement projects with the use of various funds available to non-governmental organizations. Among the diverse spectrum of local issues tackled by these organizations there is also the question of developing local agricultural markets, undertaking action aimed at developing short food supply chains and promoting the local product, both in terms of producing food and crafts (Cube Group, 2022; Jasiński & Rzytki, 2007; Ruszkai et al., 2021). These products often represent unique local features resulting from long-term historical and cultural traditions, and are part of the region's offer directed at tourists (Furmankiewicz & Trnková, 2022; Jasiński & Rzytki, 2007). 324 LAGs have been operating in Poland between the years 2015-2023 (within the 2014-2020 UE Programming Period). LAGs are required to maintain their own websites as platforms for information regarding their activities and the competitions they organize (Cejudo-García et al., 2022; Ruszkai et al., 2021).

The aim of our research was to determine to what extent do the LAGs from two regions of Poland (Lower Silesia and Lesser Poland) promote local (and traditional) products by small producers based in their area of operation through their websites, thus contributing to the development of short food supply chains.

2. Local Products in Short Food Supply Chains

The desire to shorten food supply chains in order to reduce the costs resulting from transport and brokerage is not a new economic trend. For most of human history fulfilling nutritional needs was pursued through traditional means, involving direct contact between the producer and the consumer (Chaturvedi et al., 2014). Unfortunately, in recent decades, as a result of the intensifying and uncontrolled processes of globalization and concentration of land and capital, strong price competition and the industrialization of agriculture, the world is dealing with unsustainable development in the agri-food sector (Raftowicz, 2022). A manifestation of this is the currently dominant form of food distribution, based on long (often global) supply chains, which generates negative economic, social and environmental effects in the development of many traditional rural areas. Hence, the end of the 20th century saw an increased interest in the development of alternative supply chains which emphasized the promotion of local sales and the restoration of beneficial relations between food producers and consumers, taking into consideration the principle of sustainable development (Brunori, 2007; Goodman, 2003; Goryńska-Goldmann, 2019; Marsden et al., 2002; Ploeg van der & Frouws, 1999; Ricketts Hein et al., 2006). These issues have also been reflected in the EU policy, where the shortening of food supply chains has been included in the European Green Deal initiative for a sustainable economy, which is expected to establish new directions for development by the year 2050 (Kapała, 2022b; Poponi et al., 2021). The Farm to Fork (F2F) Strategy published in 2020 has also outlined a vision for the future of the

agri-food sector in EU (Schebesta & Candel, 2020). The implementation of this strategy will depend to a large extent on local capacity for cross-sectoral cooperation in the implementation of sustainable agriculture, including support for short supply chains (Poponi et al., 2021).

The idea behind short food supply chains is for the process of supplying agri-food products to be pursued with respect to the principles of sustainable development, which is based on three types of proximity: (1) physical – meaning local sales, (2) organizational – aimed at reducing the number of links in the supply chain and (3) social – consisting in constant communication and diffusion of knowledge between the producer and the consumer (based on trust), which is associated with the presence of social capital (Evola et al., 2022; Kapała, 2022a; Malak-Rawlikowska et al., 2019; Raftowicz, 2022).

A key element of short food supply chains is their local character (Kalfagianni & Skordili, 2019; Morris & Buller, 2003). A product is local or regional when food is produced, processed, marketed and consumed in a designated geographical area, while the product itself has unique characteristics, such as: taste, freshness, high quality, cultural identity, local tradition, local speciality, environmental value, health benefits or compliance with the conditions of sustainable production (Bresso, 2011).

For the offer of local products and short food supply chains to function efficiently, there is a need for cooperation between various local stakeholders, including those from rural and surrounding urban areas (Dani, 2015; Kachniarz & Raftowicz, 2020; Skrzypczyński et al., 2021; Struś et al., 2020). A significant impact on the functioning of short food supply chains (apart from networks of producers and sellers) is exerted by non-governmental organizations – including LAGs, which develop strategies for implementing local initiatives and often support or develop the functioning of local supply chains from producer to consumer in their area of operation (Cube Group, 2022; Ruszkai et al., 2021).

3. Methodology

The analysis covered 17 LAGs with their seats located in the province (voivodeship – self-governing region) of Lower Silesia (Dolny Śląsk) and 32 LAGs with seats located in the province of Lesser Poland (Małopolska) (Figure 1). In both these provinces tourism and agritourism are an important sector of the economy, fervently pursued especially in mountainous border areas (Potocki et al., 2014; Przybyla & Kulczyk-Dynowska, 2019; Stacherzak & Hełdak, 2019; Więckowski, 2010), which favours the sale of local traditional products. To a large extent, local governments and LAGs from both provinces also benefit from EU funds (Biczkowski et al., 2021; Kachniarz et al., 2019).

The first stage of the analysis involved an inventory of LAG websites, which were then subjected to a standard content analysis (Neuendorf, 2002). Efforts were made to answer the following research questions:

- Does the LAG promote local products on its websites?
- If so, how many local producers from its area are promoted by the LAG?
- Was there a catalogue available for download on the website in the form of a document with product photos and contact details enabling contact with this manufacturer?

- Does the website link to other websites of local producers?
- Does it have its own local product certificate with a logo, awarded to local products of consistent quality?
- Does it have its own online store that allows the customer to buy goods from local producers?
- If it has an online store, how many products can be purchased there?

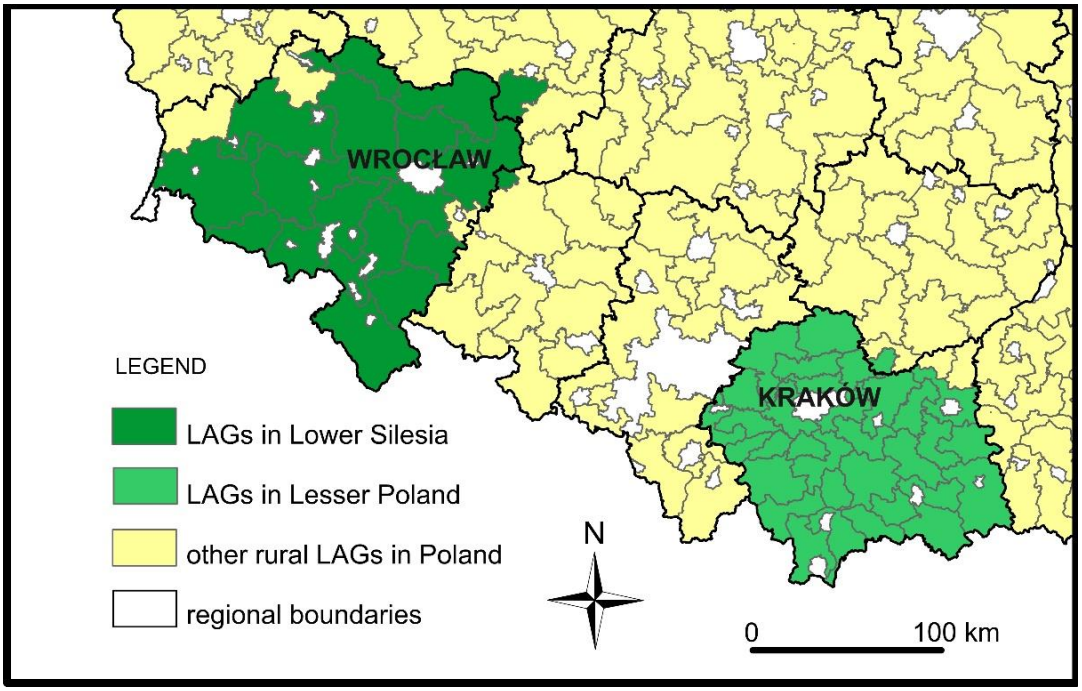

Figure 1. Territorial range of LAGs covered by the research in Lower Silesia (Dolny Śląsk) and Lesser Poland (Małopolska). Note: LAG borders do not coincide with the borders of regions. Source: authors' own elaboration

The analysis took into account only information from LAG websites in the form of permanent subpages or additional websites to which the LAG home websites referred, but which were clearly described as promoting local products and maintained by a given LAG. One-time information provided in the news section that appeared temporarily, about local fairs, producers, local promotional events taking place at a given time was not taken into account, as it did not enable a permanent search for products by a potential local or external customer, who could read the information on the website at any time. The analysis was carried out in the first half of 2022.

The analysis included only food products that can be purchased on the spot from the producer, in local retail and catering outlets or by mail order. For example, highlighted recipes for local dishes for self-preparation were not taken into account.

4. Results

The promotion of local products, usually sold within the framework of short supply chains, was regularly conducted on the analysed websites of 11 LAGs from Lower Silesia (64% of the existing total) and 15 LAGs from Lesser Poland (46%) (Figure 2). The websites listed either specific products or manufacturers who often offered several products.

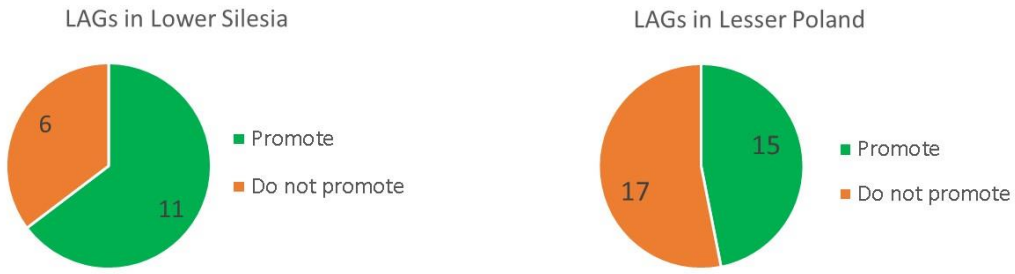

Figure 2. Number of LAGs from the Lower Silesia and from Lesser Poland provinces, which consistently promoted local food producers on their websites. Source: authors' own elaboration

The most frequently promoted products included vegetable and fruit preserves, honey, bakery products, confectionery, sometimes delicatessen products such as dumplings, less often local wines. The LAGs from Lower Silesia which promoted a local product, listed between 4 and 37 producers along with their products. LAGs from Lesser Poland – between 3 and 23 producers along with their products. In six LAGs in Lower Silesia local products (dishes) were promoted in eating establishments, while in the Lesser Poland – in seven LAGs. Five LAGs from Lower Silesia and a single LAG from Lesser Poland offered direct links to the homepages of the local producers they promoted.

Various types of catalogues listing producers or local products were offered for download by nine LAGs from Lower Silesia (52%) and another nine from Lesser Poland (only 28% of all LAGs from this province) (Figure 3). Most often these catalogues were prepared in the form of a document in the Adobe pdf format and printed in colour. They usually included not only food products but also crafts, and often also local services. The catalogues enabled direct contact with the producer in order to purchase their products.

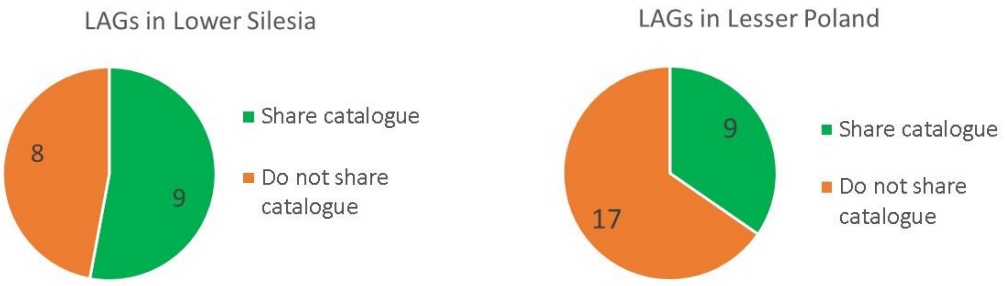

Figure 3. Number of LAGs from Lower Silesia and from Lesser Poland, which made available on their websites a catalogue of local products in the form of a document file. Source: authors' own elaboration

Some of the surveyed LAGs reported on their websites that they had organized certification procedures for a local product from their area of activity, which usually made use of a special promotional logo (Figure 4). In Lower Silesia, six LAGs informed about having granted a local product certificate (35%), just as six LAGs from Lesser Poland (only about 19% of LAGs operating there). In Lower Silesia, from 3 to 31 local food products were certified, while in the province of Lesser Poland from 3 to 22 such products.

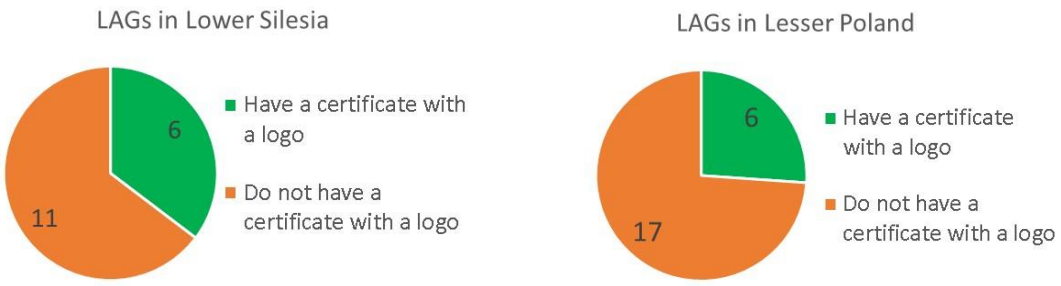

Figure 4. Number of LAGs from the Lower Silesia and from the Lesser Poland which informed on their websites about having granted a local product certificate with its own logo. Source: authors' own elaboration

In Lower Silesia the largest number of certified food products were offered on the local market by the "Ślężanie" LAG, the "LAG for sustainable development of the municipalities of Kąty Wrocławskie, Kobierzyce, Siechnice, Żórawina, Domaniów – Leader A4" and "Partnerstwo Doliny Baryczy (Partnership for the Barycz Valley)". For example, the Partnership for the Barycz Valley has developed the local brand "Dolina Baryczy Poleca (Recommended by the Barycz Valley)" (Figure 5). It is one of the better functioning territorial partnerships located in a fishing region (Glinka, 2015; Raftowicz et al., 2021; Tokarczyk-Dorociak et al., 2016). The products are promoted on the LAG's website, where one can find a description of each product, including its distinguishing features, how friendly it is towards the environment and the customer, as well as information on wholesale and retail sales (including the manufacturer's contact details). The producer can directly apply for a slot in the "Products and services from the Barycz Valley region database", free of charge.

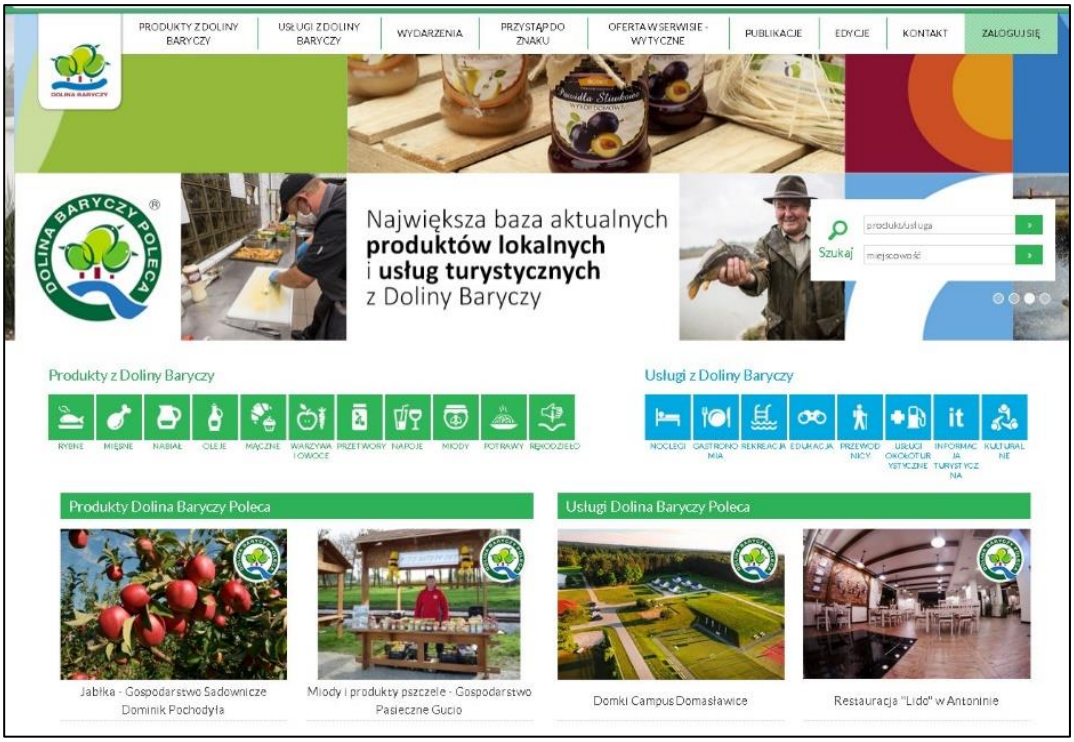

Figure 5. Screenshot of a fragment of the webpage promoting local products with the "Recommended by the Barycz Valley" certificate (accessed 1/12/2022).

In Lesser Poland the highest number of certified local products was offered by the Carp Valley LAG Association and the Raba Valley Association LAG.

Only two LAGs from Lower Silesia have set up an online store with the possibility of direct mail order sales: the "Partnerstwo Ducha Gór (Mountain Spirit Partnership)" LAG and the "Kraina Łęgów Odrzańskich (Land of Odra River Riparian Forests)" LAG. Unfortunately, the first organization offered only four food products (honey and juice), while the second one restricted their offer to several pre-prepared sets of products.

5. Discussion and Conclusions

The surveyed LAGs from two Polish provinces, with a few exceptions, have managed the promotion for the local products market on their websites relatively poorly, focusing on their main task of redistributing funds for local activities on the basis of organized grant competitions. One interesting initiative aimed at developing local agricultural markets is the certification of quality local products, which receive a distinctive logo signifying the area of their production and thus providing additional recognition. This increases the chances of small producers (including farmers) of selling this type of products and thus aids them in the earning of their income and improving their quality of life.

It is important to note that the authors of this study evaluated the permanent offers of local products on LAG websites and did not comprehensively analyze the implementation of local projects in the field of short food chain development. The latter issue might actually attract greater interest, but the surveyed websites provide little to no information which would contribute to its analysis.

LAGs are bottom-up initiatives of residents, local organizations and companies, as well as local governments. Their joint involvement in the promotion of local, often traditional products manufactured in non-industrial quantities, can be of great importance for the creation of local cooperation networks that will help to increase the income of people engaged in agricultural activity and small entrepreneurs. The promotion of these products is of great importance for popularizing the idea of short food chains – with food sold on the market to local residents and tourists. These activities can be of great importance in the social dimension, stimulating the activity of the local community (including farmers and owners of farm involved in agritourism). It is also a viable source of local food security in the event of global supply network crises.

Overall, it can be summed up that the analysed LAG websites (with a few exceptions) are generally of limited significance in the process of promoting local agricultural markets. This may result from them being short-staffed (LAGs usually employ at most a few full-time employees) and from the fact that the LAGs themselves have to obtain funds for promotional activities from other grant competitions or from contributions by local food producers and processors. One can also wonder what format of a dedicated website would be most suitable for the promotion of the local products of a given region among different types of users (tourists, residents) and whether LAG websites are the best place for this type of promotion. This is a broader problem that is not considered in this paper. Examples of good practice from the most active LAGs show that these organizations have a certain potential in developing

the sale of local products within short supply chains (Cube Group, 2022), it is just that it is not fully utilized. It is recommended to prepare funds for LAGs and other local stakeholders for projects involving the promotion and development of local product sale within short supply chains, including the employment of additional staff responsible for the organizational dimension of the undertaking.

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Assessing The Relationship Between Regional Policy Indicators in Visegrad Four Countries

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Abstract: Regional policies are paramount for the development of any country. These policies are formulated over the years in lieu of demands from the region and time concurrently. Initially, policies are focused on bridging disparities but recently targeting entrepreneurship and quality of life development. However, these policies are faced with various problems. The study aims at identifying the interrelationship between selected regional policy indicators in EU Visegrad four group of countries. Secondary data from the OECD on regional disparity, entrepreneurship, innovation, and quality of life indicators pertinent to the selected regions were used for the analysis. Data used for the analysis were from the years 2008, 2012, and 2016 with a four-year lag period. Correlation analysis was undertaken using the DisplayR software in this research. The research found that there is a continuous mixed relationship between Regional Disparity, Entrepreneurship, Innovation, and Quality of Life indicators with the Innovation variables showing highest positive correlations in the countries. Furthermore, the higher the disparities, the lower and the quality of life and vice versa, hence the regional disparity indicator poses a significant effect on the quality of life.

Keywords: regional policy; Visegrad group countries; indicators; correlation analysis

JEL Classification: J18; R11; C26; N34

1. Introduction

The study aims to examine the relationship between regional policy indicators in V4 countries (Slovakia, Hungary, Poland, and the Czech Republic) following their inclusion in the EU in 2004. The EU dedicated a budget towards regional policies to reduce disparities and promote cohesion among new member states with a lower per capita GDP. The goal of these policies is to promote economic growth, reduce poverty and improve citizens' quality of life by increasing competitiveness and employment in regions.

The V4 countries, joined the EU in 2004 and now form a Central European political and economic forum. They have diverse strides in regional policy success and varying economic backgrounds. Regional policy is crucial for long-term economic success, with goals to promote GDP growth, reduce poverty, and improve residents' quality of life. This policy also aims to eliminate inequalities, increase competitiveness, and improve the quality of life of citizens in the new member states. The concept of regional policy indicators has been influenced by various theories and has been challenged by globalization and the rise of economic geography. The right regional policy is crucial for social progress, while wrong or imprecise policies can be

harmful (Jacobs & Šlaus, 2010). Several studies have explored regional policy indicators in European countries and the need for these indicators for economic and social development (see Ehrlich et al., 2012; Ferry & McMaster, 2013; Gal & Lux, 2014; Káposzta & Nagy, 2015; Faragó & Varró, 2016). However, little research has been done on the relationship between these policy indicators. The need for a competitive and dynamic regional policy indicator is essential for a country to achieve total economic and social growth (Iammarino et al., 2019).

The V4 countries were selected for spatial analysis due to their proximity and shared EU membership since 2004. They represent a Central European forum promoting shared interests in various areas of development. The study contributes to literature on regional policy by documenting a mixed relationship between regional policy indicators in all V4 countries. The Czech Republic and Poland have strong economies fueled by policy funding and labor market growth, but regional disparity still affects quality of life.

2. Literature Review and Preposition

The European Union regional policy started in 1975, aimed at solving economic, social, and political challenges in poorer regions. The policy was established after the European Economic Community in 1958. Researchers have focused on rising economies in Europe and their impact on labor migration and poverty (Pekovic, 2017; Mehedintu et al., 2019). Advancements in globalization and integration have led to increased labor migration in transition countries compared to older EU members. Poverty is prevalent in advanced transition economies that are transitioning from developing to developed economies (Butkus et al., 2020).

Regional policy is a crucial aspect of government policymaking in the European Union and is considered necessary in the V4 countries. These countries have different socio-economic and political issues compared to older EU members and vary in their success with regional policy and economic background. Despite these differences, the momentum for regional policy indicators only increased due to external factors, primarily the European Union, pressing the central administration to prioritize regional policy issues (Bache et al., 2020).

The link between regional disparities and people's quality of life is becoming a hot topic in politics and social development plans. Regional policy aims to reduce regional disparities and improve the quality of life for those who live in a certain area. It is one of the factors that goes under the general phrase "quality of life," measured using Poverty Gap, Income Inequality, Employee Compensation and Tax Revenue which is significant in assessing social growth. The Economist Units established the quality of Life indicator in 2005 to measure the standard of living and life satisfaction in specific countries.

This index relates subjective survey results to objective factors to compare quality of life across countries (Karmowska & Marciniak, 2014). The index includes indicators such as poverty gap, income inequality, employee compensation, and tax revenue. The relationship between regional disparity and entrepreneurship in the V4 countries shows a positive correlation between unemployment and population rate with entrepreneurial activity, specifically self-employment (Tudorache, 2019). Research confirms that R&D is necessary for regional attractiveness and can help bridge unemployment, highlighting the connection between regional disparity and innovation (Radulescu et al., 2018).

Also, The relationship between quality of life and regional disparity cannot be ignored as regional disparity is damaging quality of life and driving people to relocate, worsening the situation in peripheries. Therefore, both economic distribution and redistribution should be considered (Ubarevičienė et al., 2014; Navicke & Lazutka, 2018). Research shows that GDP has a significant impact on reducing poverty and improving quality of life (Butkus et al., 2020; Grdinić, 2017). Studies have also explored the relationship between quality of life and entrepreneurship and found that increased GDP leads to a decrease in poverty for better quality of life. Examples of such studies include (Vodă & Florea, 2019; Radulescu, 2018).

As income increases, some money is saved and invested. Families receiving transfers can participate in previously unavailable activities and use the payments as start-up capital for businesses. Research by Dajcman (2020) found confidence transmission from Germany to several V4 countries that led to entrepreneurship. The presence of both vertical and horizontal motives of entrepreneurship suggests a shift towards a more bottom-up approach over time (Stack et al., 2017; Veremchuk, 2020; Okoń-Horodyńska et al., 2018).

Some researchers have explored the impact of quality of life on innovation in the V4 countries (Popovici and Calin, 2015). A study by Cieślik found a positive effect of innovation participation and quality of life in the V4 economies (Cieślik, 2022). Indicators of innovation, such as computer use at home for work and learning, and internet access, have been categorized by organizations such as the OECD and World Bank as they improve productivity and information sharing. Estonia has a more advanced internet use compared to many Western countries due to its traditional banking system (Colombo & Martinez, 2020). Innovation can lead to increased knowledge and know-how, which can have a significant impact on product and process improvement and the ability to introduce improved products to the market (Odei et al., 2021).

The findings above align with the EU's policy agenda for growth and job creation, Europe 2020, which aimed for smart, sustainable, and inclusive development to improve competitiveness and productivity (Eskelinen, 2004). The strategy has made significant contributions to the EU's socio-economic development, but further progress is needed to stimulate R&D investment and fight poverty and social exclusion. Antti and Kaisa (2011) report limitations in the relationship between indicators like technology, productivity, and economic growth.

The study aims to explore the relationship between selected regional policy indicators in the V4 countries and determine if the relationship is positive or negative. The persistent challenges will be identified and the differences between the indicators in the V4 countries will be explored. The findings will contribute to a higher level of performance of the regional policy. Further research is needed to fully understand the interrelationship between the indicators.

2. Methodology and Data

The NUTS classification (Nomenclature of territorial units for statistics) of regions given a whole country representation as a region was adopted for this research (Eurostat, 2019). Hence, the number of units analyzed is V4 countries, i.e., the Czech Republic, Hungary, Poland and Slovakia. Data for the empirical analysis were taken from the OECD and World

Bank for the period between 2008, 2012, and 2016. The above periods were selected in light of the economic depression that happened between the years 2008 to 2010 (Verick & Islam, 2011; Chang et al., 2013; Plešivčák, 2020; Mura et al., 2020).

The study is described as a comparative study that will analyze data gathered from the OECD (Melecký & Skokan, 2011). The selected indicators come from EU structural indicators and the Europe 2020 strategy and reflect the level of economic, social, and territorial policies. The data will be analyzed for each of the individual V4 countries. correlation analysis is carried out to determine the relationship between variables. To estimate the significance of one variable on another, the Pearson correlation coefficient is mostly used, which is adapted in this paper (Sensuse et al., 2015). The Pearson correlation is mathematically represented by:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{(n\sum x2 - (\sum x2)(n\sum y2 - (\sum y)2}} \quad (1)$$

Where:

r = Correlation coefficient

n = the number of pairs of scores

$\sum x$y = the sum of the products of paired scores

$\sum x$ = the sum of x scores

$\sum y$ = the sum of y scores

$\sum x2$ = the sum of squared x scores

$\sum y2$ = the sum of squared y scores

The results of the analysis in the figures below indicate how the indicators have a varied correlation with one another in the respective V4 countries. The results show the strength of

Table 1. Description of indicators and variables used – Part 1. Adapted from OECD Stat and World Bank Database.

Indicators	Variables used (Abbreviations)	Description	Source
Regional Disparity (D)	Unemployment Rate (Unemp)	The numbers of unemployed persons as % of the labor force.	Egeberg (2010); Almeida et al. (2020)
	Labor Force (Labor Market)	labor force is persons who fulfil the requirements for inclusion in working class	Melecký and Skokan (2011)
	Population Rate (Popu)	The annual total changes in population (%).	Melecký and Skokan (2011); OECD (2016)
	Gross Domestic Product (GDP)	GDP per capita in PPPs, US dollars	OECD (2016)
Quality of Life (Q)	Poverty Gap (Povty. Gap)	The difference between the poverty threshold and disposable income of the poor).	OECD (2016)
	Income Inequality (Income. Ineq)	Level of Household disposable income in a particular year.	OECD (2016)
	Employee Compensation (Emp. Comp)	Gross wages and salaries payable in cash or in kind, and the total contributions paid to employers.	OECD (2016)
	Tax Revenue (Tax Rev)	Revenues collected from taxes and other (% of GDP).	OECD (2016)

Table 1. Description of indicators and variables used – Part 2. Adapted from OECD Stat and World Bank Database.

Indicators	Variables used (Abbreviations)	Description	Source
Entrepreneurship (E)	Business Confidence (B. Confi)	Total amount of Information on future developments.	OECD (2016)
	Foreign Direct Investment (FDI)	The value of cross-border transactions related to investment during a given period (% of GDP).	OECD (2016)
	Self-Employee (Self. Employ)	People whose primary activity is self-employment and who employ others	OECD (2016)
	Inventors (Invent)	Share of total number of inventors of patent families (in %)	OECD (2016)
Innovation (I)	Information Technology Goods Export (ICT. Exp)	ICT goods export is based on the World Customs Organization Harmonized System (in million USD).	OECD (2016); Cieślik (2022)
	Access to Computers at home (Access. Comp)	Proportion of households with computer access at home (%).	OECD (2016)
	Internet Access (Internet)	Proportion of households with Internet access at home (%).	Colombo and Martinez (2020)
	Research and Development (R&D)	Total expenditure (current and capital) on R&D carried out by all institutions (% of GDP).	Schot and Steinmueller (2018)

the relationship between sixteen observed variables which represent one of the indicators characterizing regional policy. Out of these, the linear correlation was analyzed in 120 pair of variables for each country.

3. Results

We initiate our discussion by providing the detailed analysis explained by our model. Interpretation of the correlation coefficient values is used according to the statistic 'DisplayR' software. From the point of view of the achieved results of the correlation coefficient *r*, the values of strong correlation in interval above 0.60 ± 1 and perfect correlation (± 1) are important.

The result for a model representation of Poland is shown in Figure 1.

As seen in Figure 1, the results show a strong positive correlation (as one variable increase so does the other and vice versa). An observation of (38) 33.3% pair of variables is seen in our first results, of which (4) 3.33% pair of variables reached perfect positive correlation (r = +1) in Poland. In figures, there are colored darkest and dark blue and white letters. Non-surprisingly, perfect positive correlation has the pair of variables household having a personal computer with internet access, and household with the personal computer with variable poverty gap. Other perfect positive correlation relationships indicate pairs of variables – the households with internet access and R&D expenditure, and variable of poverty gap with GDP. The latter relationship can be explained that the higher level of GDP means lower percentage by which the mean income of the poor falls below the poverty line. Other

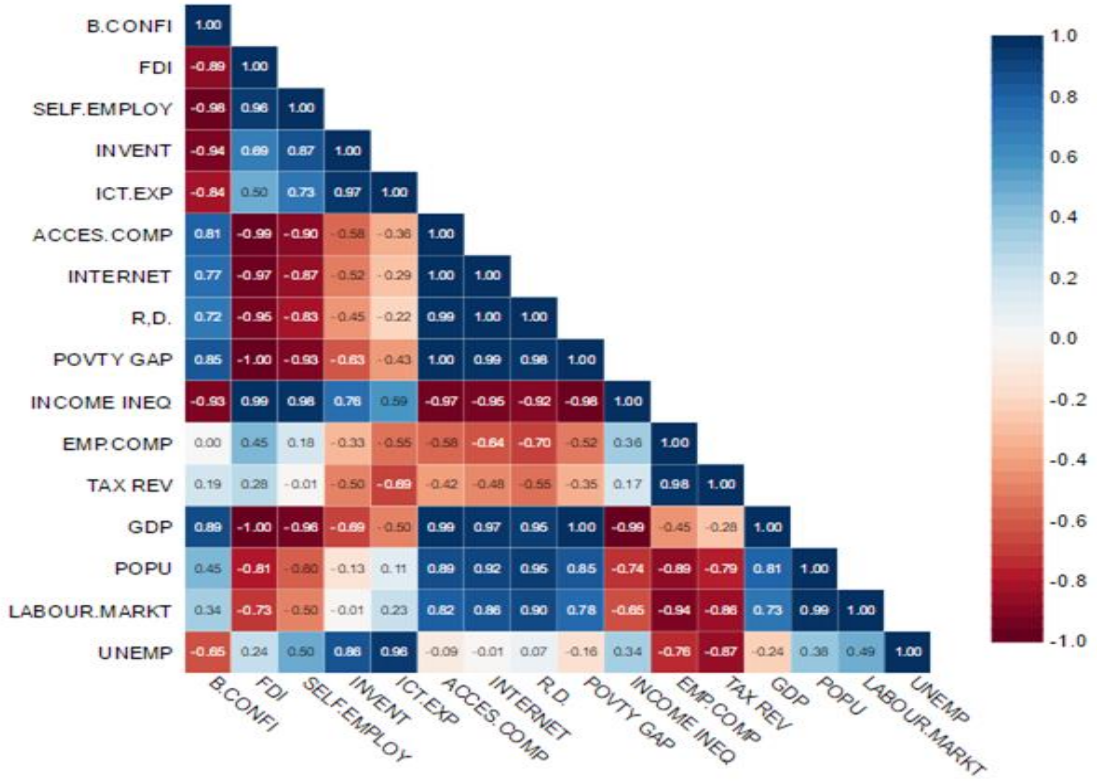

Figure 1. Correlation analysis for Poland (Legend: ± 0.29 low correlation, ± 0.30 and ± 0.49 moderate correlation, ± 0.60 and ± 1 strong correlation)

variables which relate to Innovation activities indicate a very strong positive correlation with other Innovation variables and Regional Development variables (labor market, population rate and GDP).

A strong negative correlation (as one variable increases, the value of the other decreases and vice versa) was observed in 30% pair of variables (36); the perfect negative correlation was reported in 1.67% (2) pairs of variables) – in Figure 1 with dark red color. This relationship exhibits pair of variables FDI with GDP, and FDI with poverty gap variable. The fact that FDI shows a negative correlation with GDP may mean that the Polish economy is relatively closed and does not support FDI by any financial or other incentives (FDI between observed period the FDI exhibit relative low level, they doubled in 2017 and following years). A strong negative correlation was observed as well between Business Confidence variables (FDI, number of self-employed and entrepreneurs) and some Innovation variables (households with computer access, internet connection and R&D). The other observations show that the variable poverty gap has a strong negative relation with Innovation variables and with GDP indicator. A strong negative correlation (-0.94 to -0.96) indicate income inequality with another Innovation indicator (R&D expenditure) and business confidence variable.

To determine the strength of the relationship between variables in Figure 2, we will closely observe the strongest relationship between sixteen variables in the Czech Republic, then as it was in Poland. A strong positive correlation was recorded between 38.34% (46) pair of variables, of which 6.67% (8) indicate a perfect positive correlation. Some of the Entrepreneurship

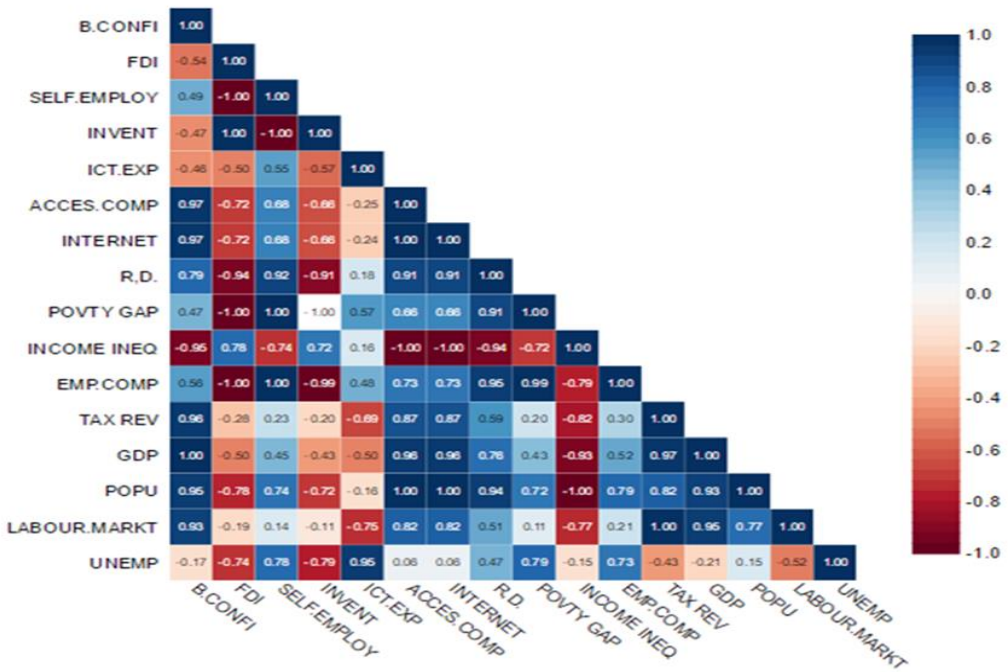

Figure 2. Correlation analysis for the Czech Republic (Legend: ± 0.29 low correlation, ± 0.30 and ± 0.49 moderate correlation, ± 0.60 and ± 1 strong correlation)

indicators illustrate perfect positive correlation (business confidence with GDP, FDI with inventors, a self-employed person with employee compensation and with poverty gap). As expected, a very strong positive relationship +0.98 indicate business confidence variable with tax revenues and with indicators of Innovation variable (household having a personal computer, internet access both +0.97).

Above mentioned Innovation indicators (household having a personal computer, internet access) are perfectly correlated with population rate and very strongly correlated (+0.98) with GDP. And as in the case of Poland, the variables household having a personal computer and internet access are perfectly positively correlated with each other. Quality of Life indicators are strongly correlated with Regional Disparity indicators. The tax revenue variable indicates a perfect correlation with the number of a labor force variable (+1.00) and GDP (+0.97); GDP is strongly correlated with the number of a labor force as well (+0.96).

On the other hand, only 22.5% (27) set of observations indicate strong negative correlations and from these observations, 5.84% (7) are perfectly negatively correlated. The variable FDI shows this relationship with two variables representing Quality of Life indicator (employee compensation, poverty gap) and self-employment variable which belongs to the same group of Entrepreneurship indicators. Another variable from the Entrepreneurship group is negatively correlated with each other - self-employment with inventor's variable. Regarding Innovation variables household having a personal computer and internet access represents a perfect negative correlation with the income inequality variable. The last observed perfect negative relationship shows the latter mention variable with the population rate variable. The group of two Entrepreneurship indicators (business confidence and inventors) show an almost perfect correlation (-0.96 to -0.99) with the income inequality and employee compensation variables.

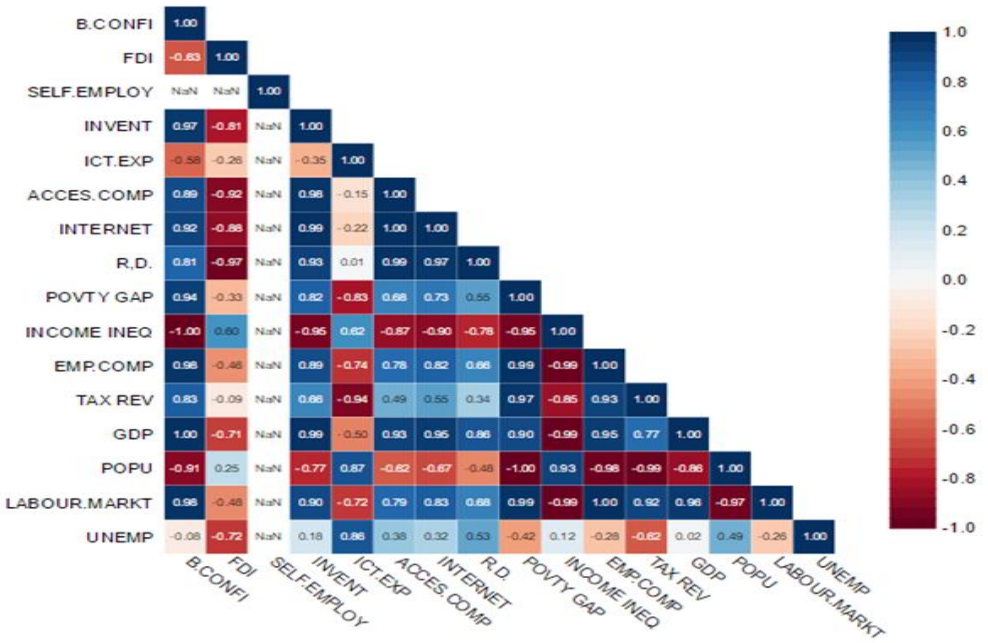

Figure 3. Correlation analysis for Slovakia (Legend: ± 0.29 low correlation, ± 0.30 and ± 0.49 moderate correlation, ± 0.60 and ± 1 strong correlation)

In the case of Slovakia (Figure 3), we observe a positive strong correlation relationship between 37.5% (45) pairs of variables, and which of that 2.5% with perfect positive correlation are. This represents variables from the Innovation category - a household with a personal computer and internet access. Another Innovation variable – business confidence is perfectly correlated with GDP. A very strong correlation was observed additionally with the variable of labor force and employee compensation (+1) and with a poverty gap (+0.99). It can be explained with relative high rates of unemployment in Slovakia which should lead to the high number of people in poverty which require additional social benefits and allowances. An almost perfect correlation exhibits inventor's variable as well with GDP, with internet access (+0.99) and with a household with a personal computer (+0.98).

Strong negative correlation represents in Slovakia a 25.84% (31) set of variables, which of them 1.7% (2) perfect negative correlation was observed. It represents the relationship between business confidence and income inequality variable (-1) and poverty gap and population rate variable (-1). Another significant negative correlation is seen in the relationship of income inequality variable and number of labor force, GDP and employment compensation (-0.99) and tax revenues and rate of the population (-0.99). This result supports our presumption of labor market characteristics in Slovakia, relative high rate of unemployment, the relatively low level of wages and salaries should mean that even though people work, their wages are not enough to cover the cost of living and that quality of Life indicator are considered unsatisfactory.

In Hungary, 36.66% of the variables showed a strong positive relationship, with 5.8% having a perfect positive correlation, such as household with a personal computer and internet access with FDI and GDP. There was a perfect positive correlation between labor force indicator and poverty gap variable. However, 32.16% of the variables showed negative significance and 5.8% had a perfect negative relationship between innovation indicator

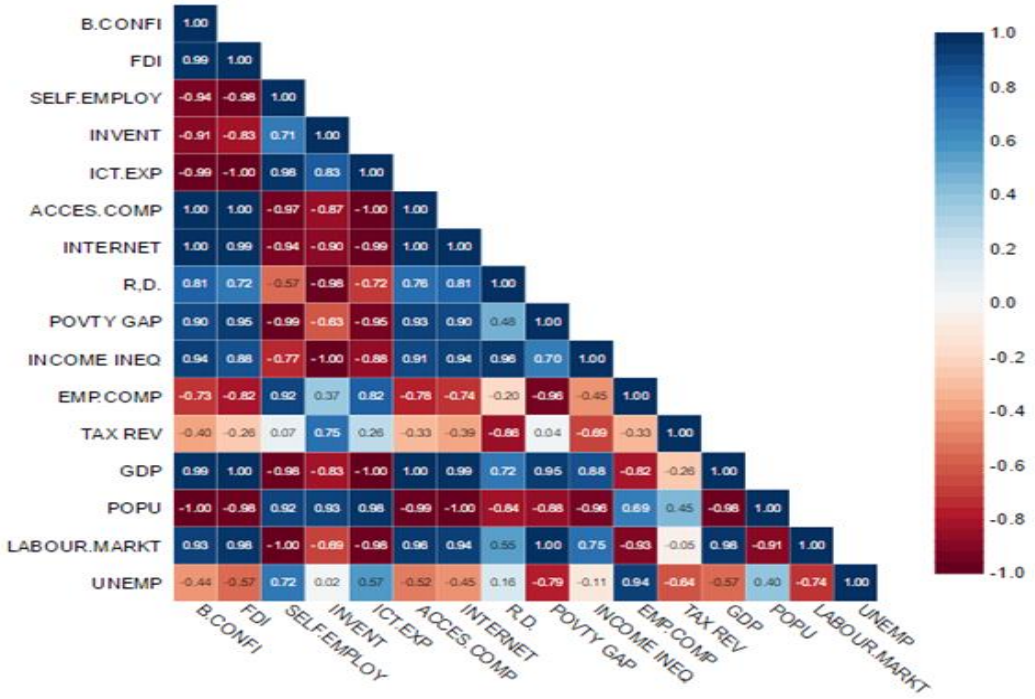

Figure 4. Correlation analysis for Hungary (Legend: ± 0.29 low correlation, ± 0.30 and ± 0.49 moderate correlation, ± 0.60 and ± 1 strong correlation)

variables and labor force variable. The population rate had a strong negative correlation with business confidence, FDI, household with a personal computer, income inequality and GDP.

4. Discussion

In each country where both significant negative and positive results are seen, it is denoted as a mixed relationship in the country. Except for Hungary, the positive relationships between variables exceeds the negative relationship in the observed countries. The number of perfect positive or negative correlations is the same in Hungary and in the Czech Republic. The results of the Czech Republic and Poland can be seen as very similar in significancy of positive correlations in respect to the Innovation indicator variables with Regional Disparity indicator variables (GDP, population rate and labor force). In Slovakia and Hungary both strong positive and negative relationship of these indicators can be seen.

The relationship between Entrepreneurship and Regional Disparity in the Czech Republic and Poland is mostly negative, while in Hungary and Slovakia it is both strong positive and negative. The research supports the findings of Dvouletý (2017) who found a negative relationship between Entrepreneurship and Regional Disparity in the European Union. The key problems of regional policies in selected EU countries have negative effects on their implementation, as established by the empirical literature. The relationship between Entrepreneurship and Quality of Life in Poland, Hungary, and the Czech Republic is mixed with both positive and negative significance. This supports the research of Vodă and Florea (2019) which shows the interdependence between Entrepreneurship and Quality of Life in terms of achieving the Keynesian theory's focus on entrepreneurship development as a means of reducing disparity.

The relationship between Entrepreneurship and Innovation in Poland is negative, while in Hungary, Slovakia, and the Czech Republic it's a mixed relationship with the strongest correlation in Hungary. This supports the idea that Entrepreneurship and Innovation are complementary and vital for organizational success. The results partly affirm the findings of Zhao (2005) and Dajcman (2020) that a combination of the two is essential for organizational success and sustainability in a dynamic environment. The results of Entrepreneurship and Innovation indicator in Poland are low, implying a low likelihood of innovation boosting entrepreneurship. Entrepreneurship and innovation are necessary components in the world of economics and management and are reflected in many businesses school programs and some economic policies and models. The need for entrepreneurship and innovation to converge is recognized in economic and social terms (Mustar, 2009; Smith & Woodworth, 2012).

Innovation and Regional Disparity shows positive correlation in Poland and the Czech Republic. This supports the idea of the importance of regional development of the "creative class" for innovation and growth (Brincikova & Darmo, 2014; Ozgen et al., 2012). Globalization demands a growing community of mobile entrepreneurial knowledge workers to spur growth in regions with a suitable environment and innovation framework (Audretsch et al., 2006; Butkus et al., 2020). The results of Innovation and Regional Disparity indicate significant representation in Poland, the highest among all countries selected. Capello (2007) supports interregional theory that output growth is determined by productivity and technology growth, but it is criticized for spillover from investment and R&D and provision of public services. Cieślik (2022) criticizes the theory for not considering spillover effects. The results support the idea of higher growth levels in regions with suitable manufacturing environment and open innovation framework.

Quality of Life and Regional Disparity have a mixed relationship, except in Poland where there is a strong negative correlation. Innovation also shows a strong negative correlation with Quality of Life in Poland. The relationships between the variables in different countries need further analysis. There is a mixture of positive and negative correlations between all four indicators, indicating that regional disparity affects quality of life. Improving access to goods and services and increasing collaboration can reduce regional disparities and improve quality of life.

5. Conclusions

In this paper, we aimed to explore the relationship between key regional policy indicators, namely, Entrepreneurship, Innovation, Quality of Life, and Regional Disparity indicators in the V4 countries. The study found a mix of positive and negative relationships regarding regional policy indicators in the V4 countries. Poland and the Czech Republic were found to be among the fastest growing economies in the V4 countries due to increases in policy funding, a strong labor market, and good employee compensation. The findings of the study are complimented by previous studies (Alacevich, 2021). Regional policies are influenced by structured policies to manage economic, social and political activities with limited resources. The primary goal of regional policies is debated as whether it achieves performance or equity, with efficiency aiming to optimize regional contribution to national

development and equity aiming to reduce socio-economic disparities between regions. The meaning of these terms varies widely.

Many countries aim to balance regional productivity and equity through their regional policies (Bachler et al., 2014). Despite this, our analysis shows that regional policies in V4 countries face challenges and are not effectively implemented. The results indicate that a higher regional disparity leads to lower quality of life and vice versa, so regional disparity has a significant impact on quality of life. The practical implications of our empirical results are far-reaching. Entrepreneurship can create jobs and stimulate economic growth, while also providing individuals with the opportunity to pursue their passions. Quality of life can be improved through the development of innovative policies, products and services by government and policy makers, Innovation can lead to new products and services that can improve the lives of people in the regions researched and provide a competitive advantage.

The limitation of our study as it aimed at identifying the interrelationship between the indicators, it relied solely on correlation analysis. Future research should possibly focus on regression analysis to ascertain the effect of one variable on another.

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Exploration on the Balanced Economic Development in the North and South of China

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Abstract: The uneven level of balanced development in economic, social, ecological and livelihood areas objectively lead to the unbalanced development of North and South regions in China. The purpose of this study is to evaluate the level of development of North and South in various aspects, clarify the influencing factors of North and South regional development and analyse the reasons behind the disparity factors, so as to provide reference basis and policy suggestions for promoting the work of narrowing the relative gap between North and South regional development in China. A comprehensive evaluation of the cross-sectional data of 22 provinces in the North and South in 2020 is conducted using the rank sum ratio evaluation method to reflect the current situation; based on this, endogenous growth model is used to explore the key factors affecting the imbalance between the North and South regional development for the panel data from 2011 to 2020.

Keywords: region gap; rank sum ratio evaluation method; endogenous growth model

JEL Classification: B16; O18

1. Introduction

In recent years, the problem of regional development, especially the uncoordinated level of development between the north and the south, has seriously hindered the pace of China's development from an overall well-off society to socialist modernization. Twenty ten reports proposed to speed up the construction of a new development pattern, focus on promoting high-quality development, and promote regional coordinated development is one of the requirements to achieve high-quality development, the formation of complementary advantages of the national spatial system has become an unstoppable trend, therefore, in the face of the current situation of unbalanced development between the north and south of China, the core problem should be identified and combined with the actual solution. The problem of north-south disparity is the result of a combination of various influencing factors, and is the result of the continuous southward shift of China's economic centre of gravity since the reform and opening up. Correct understanding of the north-south gap problem, profound analysis of the factors behind it and reasonable policy recommendations are inevitable conditions for the realization of the great rejuvenation of the Chinese dream.

Research on this issue reveals that the national transaction efficiency has been significantly improved in the Internet era, and the transaction efficiency in the south has improved faster than that in the north (Hu, 2022), and Geng (2020) used ESDA spatial data analysis to discover the differences in the economies of China's provincial administrative regions and obtain a

regional evolution map of China's inter-provincial administrative regions' economic hotspots, among others. It was found that although the development level of the north and south regions of China generally showed a growing trend, there were obvious unevenness and aggregation characteristics between regions, and their changes were mainly influenced by factors such as transaction efficiency and information industrialization. In addition, many scholars have launched in-depth analyses around also on resource heterogeneity (Dai, 2020), coefficient of variation and Sill coefficient, total factor productivity (Fu, 2006) and other issues.

The Qinling Mountains and Huaihe River is used as the boundary to divide the north-south region, which includes sixteen provinces in the south and fifteen provinces in the north. Eleven provinces are selected for the northern measurement provinces including Beijing, Shaanxi, Gansu, Hebei, Inner Mongolia, Ningxia, Liaoning, Qinghai, Shandong, Tianjin, and Xinjiang. The 11 provinces selected for the southern measure include Guangdong, Guangxi, Sichuan, Fujian, Guizhou, Hainan, Jiangsu, Shanghai, Yunnan, Zhejiang, and Chongqing. Based on the data of 22 provinces and regions from 2011 to 2020, this study establishes an indicator system with five measurement levels: economic development, innovation drive, people's life, ecological environment, and foreign investment, and uses the normalization and rank sum ratio method to conduct the measurement study, and then uses the endogenous growth model to explore the key factors affecting the gap between the north and south development levels. The findings of the study can provide necessary references and policy inspirations for the practical promotion of the coordination of the North-South development level.

2. Methodology

2.1. Construction of Index System

In " *Why Doesn't Capital Flow from Rich to Poor Countries?*", Alfaro et al. (2008) points out that the fundamental reason for the different levels of economic development in different regions and even in different countries is that the level of innovation and technology affects human capital differently, which leads to different output per unit of labor. Technological innovation can directly affect human capital through dry school, which is a kind of Harold-neutral technological progress, it is to enhance the effective labor of the labor force, improve the quality of labor and labor efficiency, and thus cause income inequality between countries and regions.

Therefore, taking into account the multiple dimensions of human capital proposed by UNESCO, the total amount of human capital is influenced by five dimensions: economic development, innovation drive, people's life, ecological environment and foreign investment, and the representative indicators in each field are selected, and the entropy value method is chosen to give the weight to each indicator.

In terms of industrial structure, we selected the industrial structure upgrade index proposed by Xu and Jiang (2015), and the Paddy-Clark law suggests that industrial structure upgrading means the change of industry and the improvement of efficiency. In order to comprehensively and accurately reflect the purpose of this paper and the connotation of industrial structure upgrading, the following draws on the study of Xu and Jiang (2015) to

construct an industrial structure upgrade index to represent the level of industrial structure upgrading, and the specific measurement is shown in the formula:

$$ISU = \sum_{i=1}^{3} I_i \times i = I_1 + I_2 \times 2 + I_3 \times 3 \quad (1)$$

The level of openness is based on the existing theoretical analysis: David Ricardo's trade theory states that an open market can lead to a wider competition and make all participants benefit, while in recent times, with the development of multinational enterprises, foreign investment theory states that foreign direct investment can cause an increase in the level of competition in the local market, with spillover effects of competition and management experience. Two dimensions are selected to measure the level of foreign investment: the total investment of FIE (foreign-invested enterprises) and the number of FDI projects.

Table 1. Composition of the index system

subsystem	Specific indicators	measurement units	data sources	weight (%)
1. economic development	Per capita GDP	yuan	State Stat. Bureau	4.509
	Urban-rural disposable income gap	yuan	State Statistical Bureau	1.575
	Urban-rural consumption expenditure gap per capita	yuan	State Stat. Bureau	1.287
	Industrial structure upgrade index	/	State Stat. Bureau	6.995
2. innovation-driven	Number of R & D personnel	person	State Stat. Bureau	11.751
	R & D personnel expenditure	ten thousand yuan	State Stat. Bureau	9.563
	Number of patents authorized	piece	State Stat. Bureau	10.334
	Sales revenue from new products	ten thousand yuan	State Stat. Bureau	11.176
3. people's life	General public services expenditure	ten thousand yuan	State Stat. Bureau	4.535
	Per capita education expenditure	yuan	State Stat. Bureau	4.317
	Health technicians per thousand population	person	State Stat. Bureau	4.019
	Engel's coefficient	%	Provincial Stat. yearbook	1.225
4. ecological condition	Energy consumption per GDP	Tons of standard coal per ten thousand yuan	State Stat. Bureau	1.079
	Percentage of forest cover	%	State Stat. Bureau	3.925
	Harmless domestic waste treatment rate	%	State Stat. Bureau	0.722
	Urban sewage treatment rate	%	State Stat. Bureau	1.469
5. foreign investment	Total investment of FIE	million dollars	State Stat. Bureau	9.629
	Number of FDI projects	number	State Stat. Bureau	11.889

2.2. Data Processing

The missing values of the variables are quickly viewed using the command misstable in the stata software, which is presented in a tabular form. Missing values are handled by

regression interpolation, using the relationship between variables to build a regression model, and for variables containing missing values, by building a regression equation of the missing term on the observed term and using the predicted values obtained from this equation to fill in the missing values.

Using the summarize command, the relationship between the standard deviation and the mean is easily determined, and then the histogram command is used to clearly determine whether there are outliers based on the generated histogram. The outlier processing is selected as a tailing process, in which the data in a set that exceeds a specified percentile value is replaced by the value near the specified percentile. When the sample data is large enough, the tailing process can help to remove the effect of extreme values.

The rank-sum ratio method was selected for the comprehensive evaluation of 22 provinces and cities in 2020. The method combines parametric and non-parametric statistics, with descriptions and inferences, and has powerful statistical information functions through the operation of rank substitution.

Table 2. Results of the linear regression analysis

	Non-standardized coefficients		Standardization coefficient	p	VIF	Adjust R2	F
	B	standard error	Beta				
constant	-0.62	0.041	-	0.000***	-	0.973	F=759.265
Probit	0.218	0.008	0.987	0.000***	1		P=0.000***

From the analysis of the results of the F test, we can get that the significance P-value is 0.000*** and the level presents significance, which rejects the original hypothesis that the regression coefficient is 0. Meanwhile, the goodness-of-fit R^2 of the model is 0.973, and the model performance is relatively excellent, so the model basically meets the requirements. For the performance of variable co-linearity, VIF is all less than 10, so the model has no multiple co-linearity problem and the model is well constructed. The formula of the model is as follows: y = -0.62 + 0.218 * Probit.

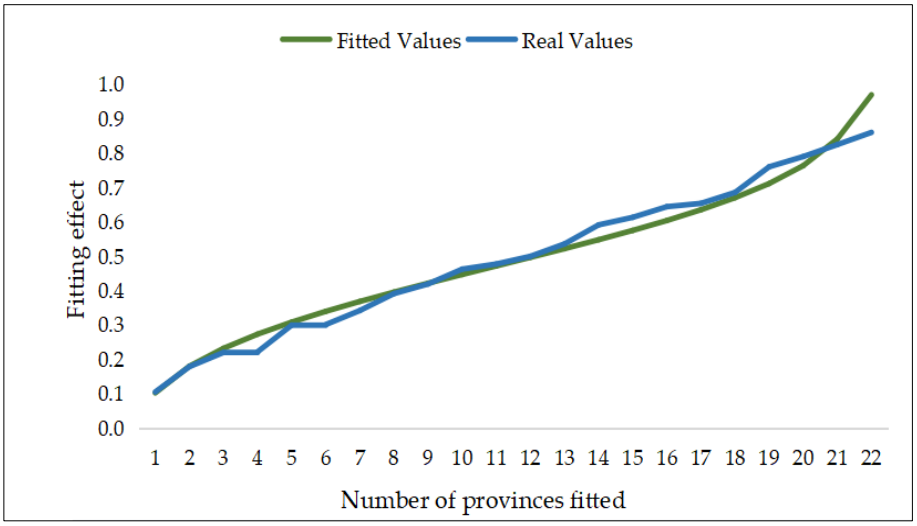

Figure 1. Fits the effect diagram

Table 3. Stile sorting critical value table

Level	The percentile cut-off value	Probit	RSR cut-off value
The first gear	<15.866	<4	<0.2535
The second gear	15.866 ~	4 ~	0.2535 ~
The third gear	84.134 ~	6 ~	0.6902 ~

Table 4. Summary of the grading and level results

Province	RSR_Rank	Probit	RSR Regression	Level
Guangdong	1	7.278	0.969	3
Jiangsu	2	6.691	0.841	3
Zhejiang	3	6.335	0.763	3
Shandong	4	6.097	0.711	3
Shanghai	5	5.908	0.670	2
Fujian	6	5.748	0.635	2
Beijing	7	5.605	0.604	2
Sichuan	8	5.473	0.575	2
Hebei	9	5.349	0.548	2
Liaoning	10	5.230	0.522	2
Chongqing	11	5.114	0.497	2
Tianjin	12	5.000	0.472	2
Shaanxi	13	4.886	0.447	2
Guangxi	14	4.770	0.422	2
Yunnan	15	4.651	0.396	2
Guizhou	16	4.527	0.369	2
Hainan	17	4.395	0.340	2
Nei Monggol	18	4.252	0.309	2
Xinjiang	19	4.092	0.274	2
Gansu	20	3.903	0.232	1
Ningxia	21	3.665	0.180	1
Qinghai	22	3.309	0.103	1

3. Results

According to the summary of the results in Table 4, there are four provinces and cities with Level 3 (the best level): Guangdong Province, Jiangsu Province, Zhejiang Province, and Shandong Province, fifteen provinces and cities with Level 2 (the median level): Shanghai, Fujian, Beijing, Sichuan, Hebei, Liaoning, Chongqing, Tianjin, Shaanxi, Guangxi, Yunnan, Guizhou, Hainan, Inner Mongolia, and Xinjiang, and three provinces and cities with Level 1 (the lowest level): Gansu Province, Ningxia Province, and Qinghai Province. Level 1 (the lowest grade) there are three provinces and cities: Gansu Province, Ningxia Province, Qinghai Province. It is not difficult to find that the development balance between the north and the south is not optimistic: only Shandong is the northern province and city among the four provinces and cities with Level 3 (the best grade), while the three provinces and cities with Level 1 (the lowest grade) are Gansu, Ningxia and Qinghai, all of which are northern provinces and cities.

The mean vectors of Level 1, Level 2 and Level 3 provinces and cities in 2020 are further calculated based on the index values after data processing, and the mean vectors of Level 1

regions are used as the benchmark, and the mean vectors of Level 2 and Level 3 are converted into multiples (the inverse of the multiples is taken for negative indicators), and Radarchart in the fmsb package of R software is applied to the plot is obtained as Figure 2. The radar map of the mean value of cross-sectional data in the north and south regions in 2020.

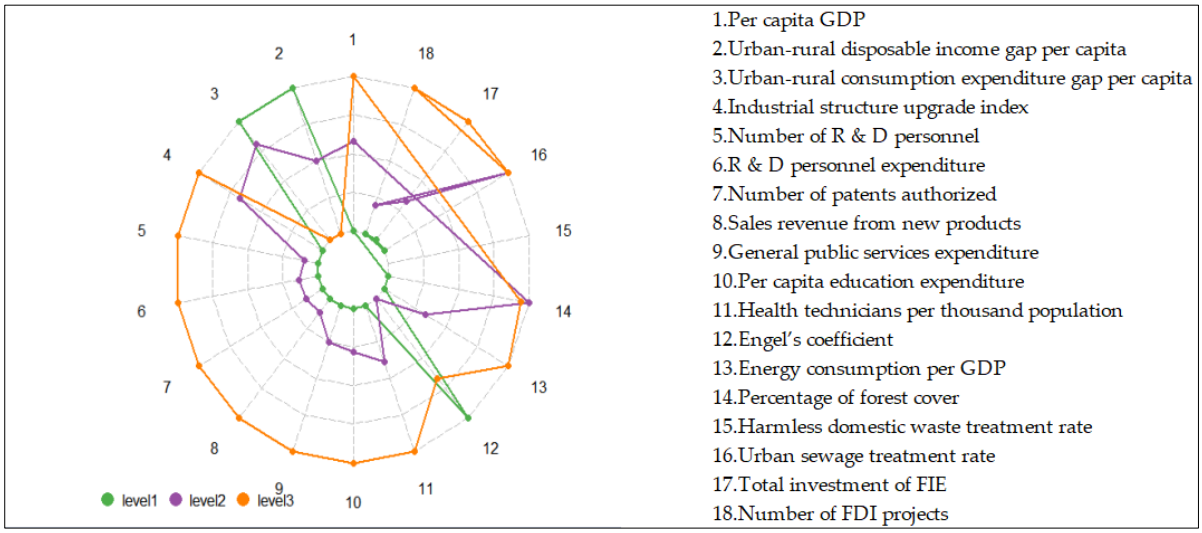

Figure 2. Radar plot of mean of 2020 section data by Level

In Figure 2, it is easy to see that the mean value of most indicators in Level 3 is much higher than Level 1, while some data in Level 2 are much higher than Level 1, and the gap with Level 3 is not significant, while some data are close to Level 1. The data show the difference between Level 1 and Level 2 in Urban-rural disposable income gap per capita, Urban-rural consumption expenditure gap per capita, Number of R&D personnel, R&D personnel expenditure, Number of patents authorized, Sales revenue from new products, General public services expenditure, and Per capita education expenditure. Urban-rural consumption expenditure gap per capita, Number of R&D personnel, R&D personnel expenditure, Number of patents authorized, Sales revenue from new products, General public services expenditure, and Per capita education expenditure, etc., urban-rural income distribution, R&D research and development, and public services still need to be further promoted, while such aspects as Industrial structure upgrade index, Harmless domestic waste treatment rate and urban sewage treatment rate is very small, implying that China is relatively average at the level of industrial structure, and the geopolitical factors do not have a large impact and incline industrial optimization and upgrading, while the same of domestic garbage harmless treatment rate and urban sewage treatment rate represents a better implementation effect at the ecological environment level such as garbage sorting policy and new regulations on sewage treatment.

4. Discussion

The capital output impact factor and human capital impact factor are constructed. The capital output factor is considered to be influenced by foreign direct investment, general public service expenditure and industrial structure upgrading index; considering the

multiple dimensions of human capital proposed by UNESCO, the total amount of human capital is influenced by multiple dimensions such as health care, education level, science and technology innovation. Therefore, with GDP per capita as the explanatory variable and other variables as explanatory variables, the following endogenous growth model is established.

$$\begin{aligned} Y &= H[\eta_t(K^{\alpha})][K_A^{\alpha 1} L_A^{\beta 1} \theta_t L] \\ \eta_t &= FDIK^{\alpha 2} FDIP^{\beta 2} G^{\xi} ai^{\theta} \\ \theta_t &= id^{\alpha 3} ie^{\beta 2} he^{\xi 2} right^{\xi 3} in^{\xi 4} \end{aligned} \tag{2}$$

Table 5. List of model-building variables

variable	Y	K	L	H	η_t	FDI	θ_t
meaning	GDP	stock of capital	The number of labor	Production function allowance	Capital output impact factor	Total investment of FIE	Human capital impact factor
variable	G	Ie	He	Id	Ai	Right	In
meaning	General public services expenditure	Per capita education expenditure	Health technicians per thousand population	Urban-rural disposable income gap per capita	Industrial structure upgrade index	Number of patents authorized	Sales revenue from new products

Both sides of the above equation are divided by L, at the same time, and then the natural logarithm is the following equation that can be statistically regressed:

$$\begin{aligned} &\ln y = \alpha 2 \ln FDIK + \beta 2 \ln FDIP + \xi G + \theta \ln ai + \\ &\alpha \ln k + \alpha_1 \ln K_A + \beta_1 \ln L_A + \alpha 3 \ln id \\ &+ \beta_3 \ln ie + \xi_2 \ln he + \xi_3 \ln right + \xi_4 \ln in + \ln H \end{aligned} \tag{3}$$

The Hausman test showed a p-value of 0.000, which suggested that a fixed effects model (FE) should be used, taking into account the time effect, and testing the joint significance of all annual dummy variables,which was found to include time fixed effects in the model.

Under the Fe_trend model, the industrial structure upgrade index has a significant positive effect on per capita GDP at the level of 5%, and the time has a significant positive effect on per capita GDP at the level of 0.1%.

5. Conclusion

In this paper, we study the balanced development of north-south regions by using panel data from 2011 to 2020, and use the comprehensive evaluation of the rank and ratio of cross-sectional data in 2020 to obtain the probit threshold value, according to which the regional ranking is graded, among the four provinces and cities with the graded level of Level3 (the best level), only Shandong is a northern province and city, while the three provinces and cities with the graded level of Level1 (the lowest level) are Gansu, Ningxia and Qinghai, all of which are northern provinces and cities. Based on this classification, a fixed-effects model with time effects is tested and selected to investigate the key influencing factors, and it is

	(1) OLS	(2) FE_robust	(3) FE_trend	(4) FE	(5) RE
lnId	0.157*	0.0668	-0.0468	0.0668	0.157**
	(0.0670)	(0.0622)	(0.0490)	(0.0501)	(0.0541)
lnai	1.245	-0.530	-2.694*	-0.530	1.245*
	(1.207)	(1.306)	(1.034)	(0.549)	(0.561)
lnright	0.0703	0.0689*	-0.0297	0.0689*	0.0703*
	(0.0364)	(0.0277)	(0.0275)	(0.0265)	(0.0295)
lnIn	0.0285	0.0487	0.0262	0.0487*	0.0285
	(0.0429)	(0.0476)	(0.0346)	(0.0231)	(0.0233)
lnG	0.130	0.474***	0.254	0.474***	0.130*
	(0.110)	(0.0815)	(0.143)	(0.0676)	(0.0627)
lnHe	0.0115**	0.00913	0.00504	0.00913*	0.0115*
	(0.00370)	(0.00453)	(0.00303)	(0.00432)	(0.00481)
lnFDI	0.0600	0.0698*	0.0360	0.0698**	0.0600**
	(0.0393)	(0.0330)	(0.0218)	(0.0215)	(0.0229)
时间			0.0733***		
			(0.0131)		
_cons	5.693***	5.638***	-136.1***	5.638***	5.693***
	(0.832)	(0.888)	(25.43)	(0.456)	(0.499)
N	220	220	220	220	220

Standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Figure 3. Summary of the empirical test results

found that the industrial structure upgrading index has a significant positive effect on GDP per capita at the 5% level.

Based on the research findings, the following policy insights are obtained from this paper:

- Development impetus should be driven from relying on factor inputs such as resources and low-cost labor to innovation. According to the conclusion of North's analysis, institutional innovation is even more important than technological invention for long-term economic growth, and institutional innovation can be optimized in terms of property rights mechanism, motivation mechanism, decision-making mechanism and coordination mechanism.
- According to local conditions, different regions should make differentiated policies, for example, the southern region should invest resources into R&D and promote the transformation of enterprises to knowledge-intensive and technology-intensive. While the northern regions should expand the scale of foreign investment and focus on scientific research and innovation, rather than building infrastructure as the main focus, in order to narrow the economic differences with the southern regions through rapid economic growth and industrial structure upgrading.

Conflict of interest: none.

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Analysis of Healthcare Expenditures in the Czech Republic

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Abstract: Healthcare expenditures play a key role in the social policy and economy of individual countries. There is increasing emphasis on the political economy aspects of health policy. Primarily due to the onset of the Covid-19 pandemic, it became clear that healthcare expenditures must be addressed comprehensively. Given that empirical findings on the relationship between gross domestic product and healthcare expenditures are diverse, an analysis will be performed for the Czech Republic. Correlation analysis and Spearman's correlation coefficient will be used to determine the independence of the investigated economic variables. The aim of the article is to perform a correlation analysis, which will verify how the change in one economic quantity affects the change of another investigated economic quantity. Correlation analysis showed that GDP has a very strong positive correlation with healthcare expenditures and a very strong negative correlation with the unemployment rate. The correlation between the unemployment rate and healthcare expenditures is negative. Through time series modeling and predictions, it was shown that in the period until 2024, we expect first a decrease and then a slight increase in healthcare spending.

Keywords: healthcare; expenditure; GDP; correlation analysis; prognosis

JEL Classification: C02; I15; H51

1. Introduction

In 2019, the world was hit by the Covid-19 pandemic, which significantly affected healthcare expenses and other expenses of the state budgets of individual countries. This pandemic was reflected in basic macroeconomic indicators such as GDP, unemployment, and inflation.

When analyzing healthcare spending, it can be found that, for example, U.S. healthcare spending increased 9.7 percent to USD 4.1 trillion in 2020, a much faster pace than the 4.3 percent increase seen in 2019. The acceleration in 2020 was driven by a 36.0 percent increase in federal spending on healthcare, which was mainly affected by the COVID-19 pandemic. At the same time, the gross domestic product declined by 2.2 percent, and the share of the economy devoted to healthcare expenses increased to 19.7 percent. Another aspect of this situation is the growth of uninsured people in the US and significant shifts in the types of coverage (Hartman et al., 2022).

In 2019, Germany had the highest total expenditure of the EU countries, Germany, which exceeded 400 billion euros in 2019. The second was France with approximately 270 billion euros. The Czech Republic, with total expenditures of EUR 17.2 billion, took fourteenth place.

Luxembourg, Denmark, and Sweden had the highest total expenditure per capita. Expenditure per inhabitant exceeded 5,000 euros. The EU average was 3,102 euros per inhabitant, which is almost twice the expenditure per inhabitant in the Czech Republic (1,611 euros). In EU countries, healthcare financing is predominantly from public sources (social and health insurance systems and public budgets). The largest amount is spent in the Czech Republic, Luxembourg, Sweden, and Germany, while the least amount is spent on health care from public sources in Cyprus (58%) and Greece (60%) (Čermáková & Lojková, 2022).

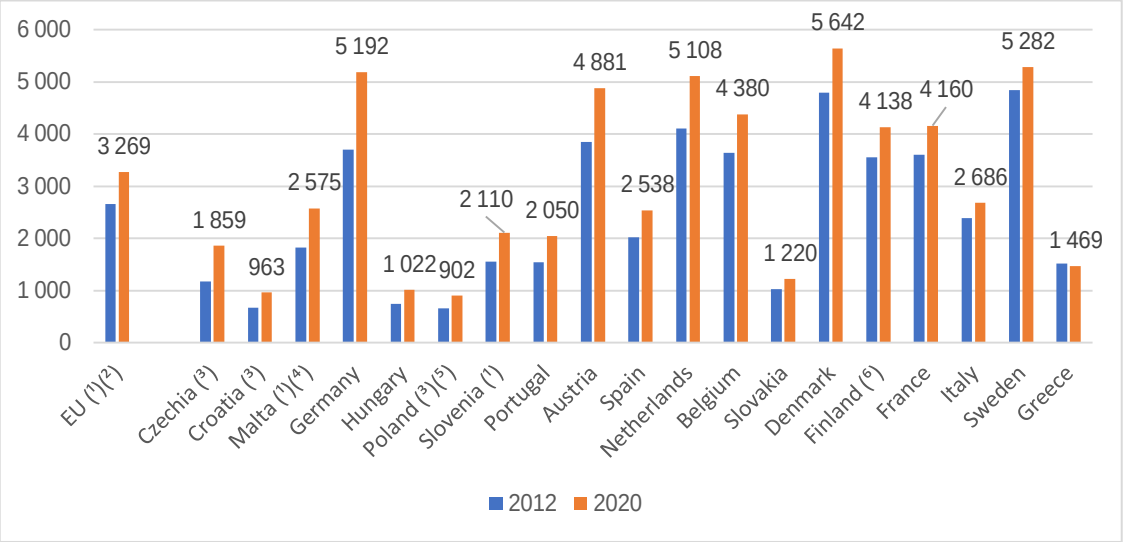

Figure 1. Current healthcare expenditure per inhabitant, 2012 and 2020 (Eurostat, 2022)

Current healthcare expenditure in the EU was 1,462,373 million euros in 2020. The highest total expenditure was in Germany at 431,805 million euros. France was again in second place with 281,065 million euros. The healthcare expenditure was 19,889 million euros in Czechia. Current healthcare expenditure in Germany and France was equivalent to 12.8% and 12.2% and in Czechia 9.2% of GDP. Health expenditures of the EU were 10.9% of Current healthcare expenditure in Germany and France was equivalent to 12.8% and 12.2% of the gross domestic product in 2020 (Eurostat, 2022).

Relative to population size and in euro terms, current healthcare expenditure in 2020 was highest among the EU Member States in Luxembourg (EUR 5,875 per inhabitant) and Denmark (EUR 5,642 per inhabitant). Furthermore, current health expenditure was higher than 5,000 Euros per inhabitant in Germany, Ireland, the Netherlands, and Sweden. Current expenditures were 1,859 Euros per inhabitant in the Czech Republic in 2020. The EU average was 3,269 per inhabitant in 2020 (see Figure 1) (Eurostat, 2022).

1.1. Current Healthcare Expenditures in the Czech Republic

In this article, we will focus on healthcare expenditures in the Czech Republic. The Czech Republic is a member of the EU and is a small open economy with 10.5 million inhabitants. More than 80% of total healthcare financing is covered by public financing. This includes mandatory public health insurance and public budgets with the former being the most important source of health financing in the country (Broulikova et al., 2020; Hedvicakova et

al., 2020; Hedvičáková & Pozdílková, 2019; Maci & Marešová, 2022). Healthcare expenditures here amounted to CZK 526.2 billion in 2020. Until 2019 (mainly since 2017), healthcare expenditures grew by an average of 8% annually. In 2020, there was an increase of 19.5% mainly due to the global Covid-19 pandemic. This increase was mainly due to higher spending from public sources. Payments from public health insurance increased by CZK 52 billion, and direct expenditures from the state budget and from the budgets of regions and municipalities increased by CZK 35 billion. In contrast, household spending fell in 2020 for the first time in the monitored period (Broulikova et al., 2020; Eurostat, 2022).

2. Methodology and Goals of the Paper

The article is based on primary and secondary sources. Data for subsequent analysis of basic macroeconomic indicators were obtained from publicly available databases, primarily Eurostat, World Health Organization, and the Czech Statistical Office, other from conferences, professional literature, information collected from the professional press, and workshops relating to the chosen subject. Predictions of individual indicators will be made on the basis of time series (Cerna et al., 2019; Hedvičáková & Pozdílková, 2018).

We will use correlation analysis and Spearman's correlation coefficient to determine the independence of the investigated economic variables. The goal of correlation analysis is to verify how much a change in one of the investigated quantities affects the change in another investigated quantity. That is, a positive correlation means that the growth of one quantity implies the growth of the other quantity, on the contrary, a negative correlation means that the growth of one quantity implies the decrease of the other quantity. Values roughly between -0.5 and 0.5 mean that the quantities are uncorrelated, i.e., mutually independent. The examined variables will be GDP per capita, the unemployment rate, and healthcare expenditures.

3. Results

Data from the Czech Statistical Office is available for the years 2008 to 2020 for Health care expenditures. Health expenditures and their development will be analyzed. Subsequently, healthcare expenditures will be compared with the development of other economic indicators – GDP and the unemployment rate.

The following Table 1 shows the data for the examined indicators:

Table 1. The macroeconomic indicators in the Czech Republic from 2008 to 2020 (Czech Statistical Office, 2023a; 2023b)

Year	2008	2009	2010	2011	2012	2013
GDP per capita	387,630	376,907	379,650	387,011	389,076	394,151
Unemployment rate	4.4	6.7	7.3	6.7	7.0	7.0
Health expenditures	264.5	301.5	334.5	338.5	342.8	346.6

2014	2015	2016	2017	2018	2019	2020
412,908	438,718	454,022	482,622	509,180	542,818	533,556
6.1	5.0	4.0	2.9	2.2	2.0	2.6
350.4	353.3	363.4	388.2	434.1	477.7	526.2

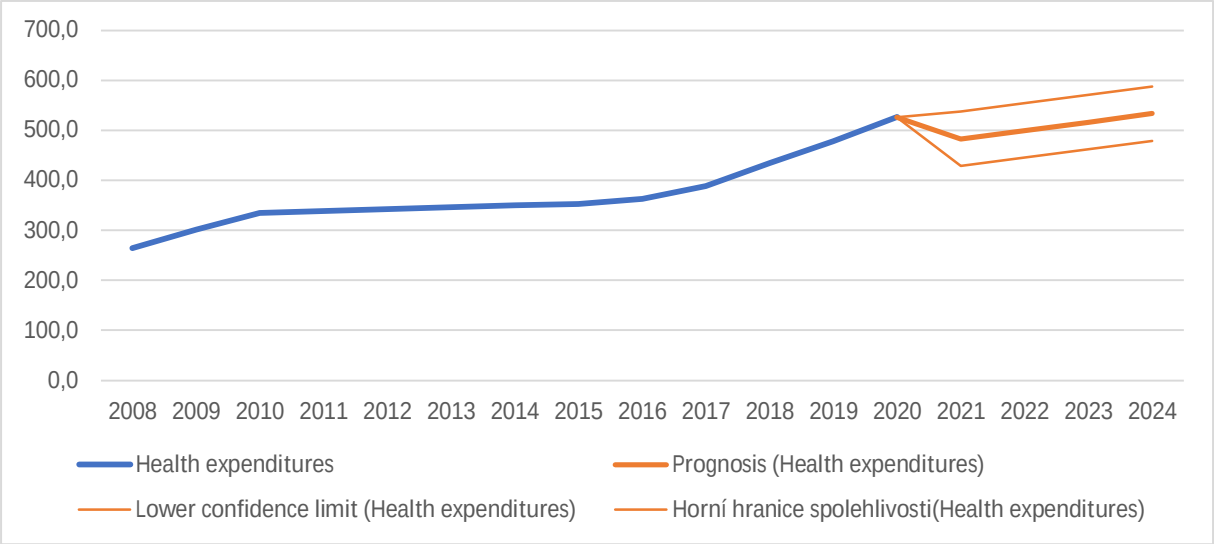

Figure 2. The development and prediction of the healthcare expenditures in the Czech Republic, (Czech Statistical Office, 2023a)

Table 2. The development and prediction of the healthcare expenditures in the Czech Republic from 2019 (Czech Statistical Office, 2023a)

Year	Health expenditures	Prognosis	Lower confidence limit	Upper confidence limit
2019	477.7			
2020	526.2	526.2	526.2	526.2
2021		482.8	428.5	537.1
2022		499.6	445.3	553.9
2023		516.4	462.1	570.7
2024		533.2	478.9	587.5

In Figure 2 we can see the development, and prediction of the healthcare expenditures.

Figure 2 and Table 2 show the forecast until 2024. It predicts first a decrease and then a slight increase of the investigated quantity.

In the following Figure 3 we can see the development and prediction of GDP per capita.

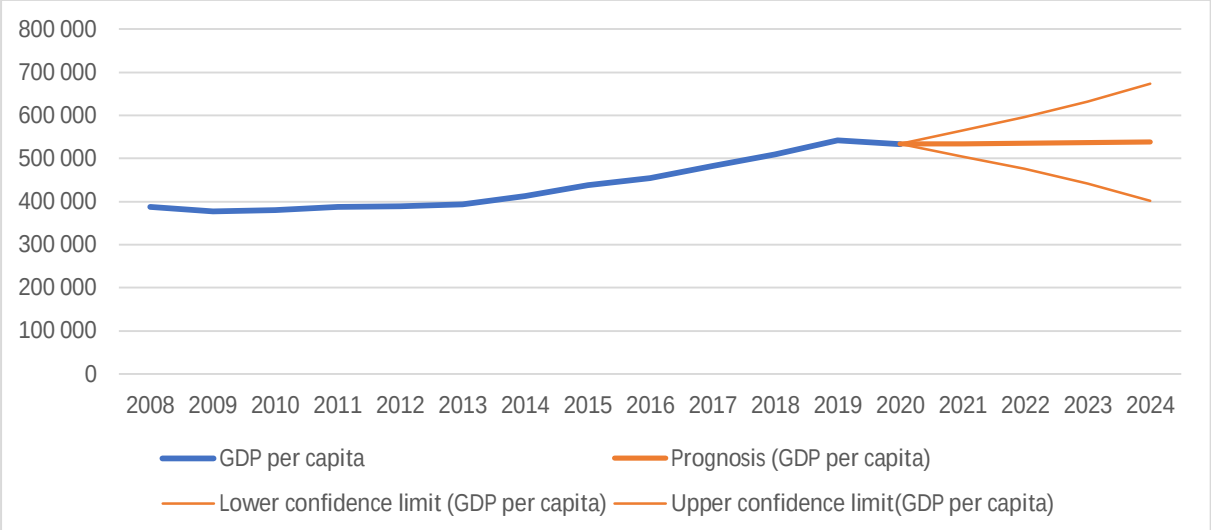

Figure 3. The development and prediction of GDP per capita in the Czech Republic, (Czech Statistical Office, 2023a)

Table 3. The development and prediction of GDP per capita in the Czech Republic from 2019 (Czech Statistical Office, 2023a)

Year	GDP per capita	Prognosis	Lower confidence limit	Upper confidence limit
2019	542,818			
2020	533,556	533,556	533,556	533,556
2021		534,698	504,917	564,479
2022		535,757	475,809	595,705
2023		536,817	441,322	632,311
2024		537,876	402,015	673,738

Figure 3 and Table 3 show the forecast until 2024. It predicts almost stagnation of the studied variable in the studied period.

In the following Figure 4 we can see the development and prediction of the unemployment rate.

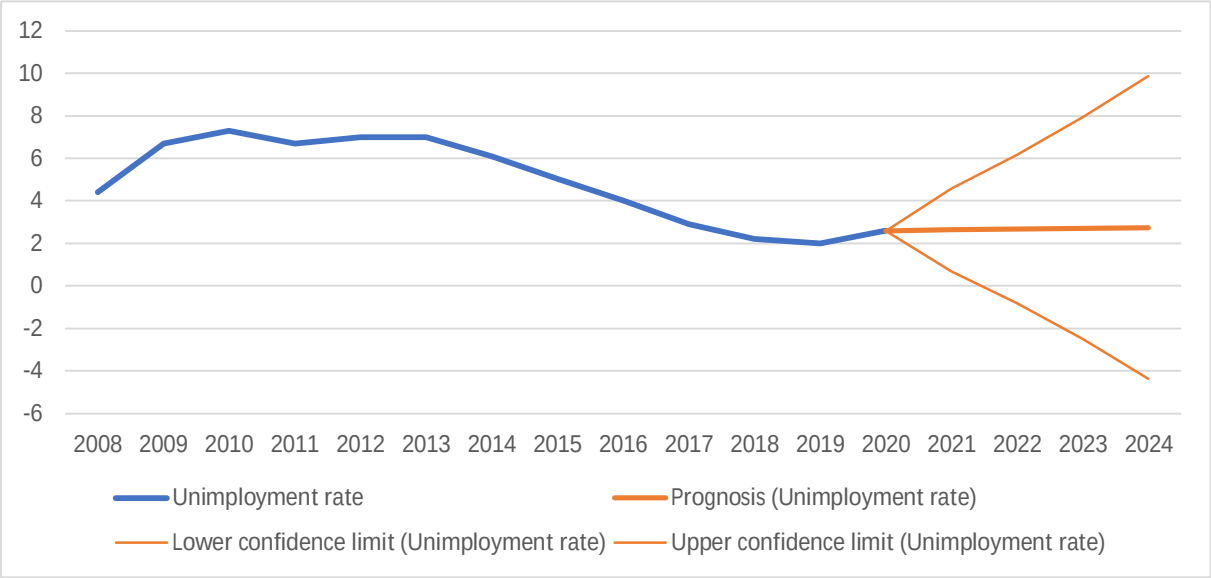

Figure 4. The development and prediction of unemployment rate in the Czech Republic (Czech Statistical Office, 2023a)

Table 4. The development and prediction of unemployment rate in the Czech Republic from 2019 (Czech Statistical Office, 2023a)

Year	Unemployment rate	Prognosis	Lower confidence limit	Upper confidence limit
2019	2			
2020	2.6	2.6	2.60	2.60
2021		2.635222176	0.69	4.58
2022		2.672695143	-0.82	6.17
2023		2.71016811	-2.51	7.93
2024		2.747641078	-4.37	9.87

From Figure 4 and Table 4, you can see the forecast until 2024. It predicts almost stagnation of the studied quantity with a slight growth at the end of the studied period.

Correlation analysis and correlation table

The goal of the following analysis is to verify how much a change in one of the investigated quantities affects the change in another investigated quantity.

The following Table 5 shows the correlations between all investigated variables:

Table 5. Correlations between unemployment rate, Health expenditures and GDP per capita

	Unemployment rate	Health expenditures	GDP per capita
Unemployment rate	1.000000	-0.711353	-0.924302
Health expenditures	-0.711353	1.000000	0.913980
GDP per capita	-0.924302	0.913980	1.000000

We will also demonstrate the correlation between pairs of investigated economic variables graphically. In the following graphs, we can see the dependence of individual pairs of investigated quantities.

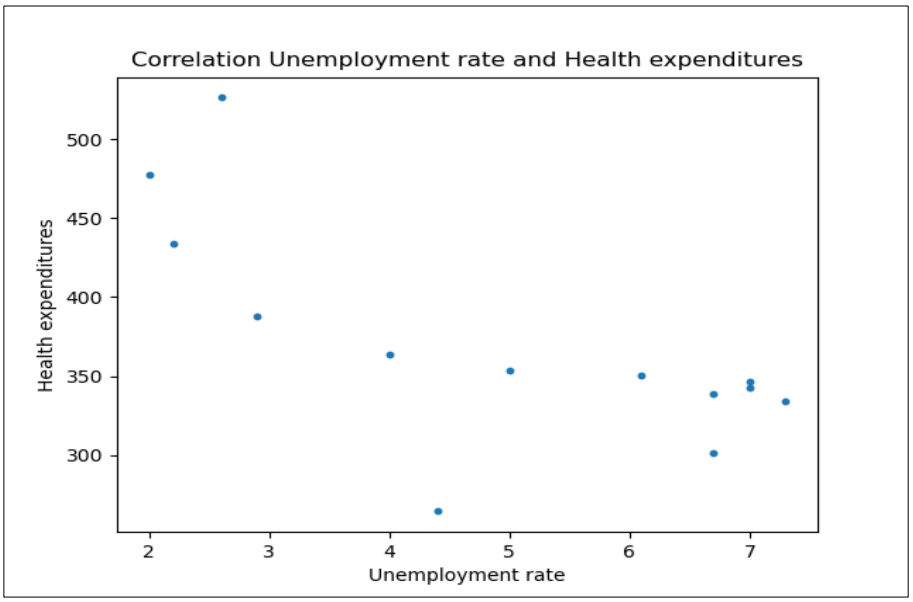

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Figure 5. Correlation between unemployment rate and health expenditures

The correlation between the unemployment rate and health care spending is -0.711353, which indicates a negative correlation, which can also be seen from the previous Figure 5.

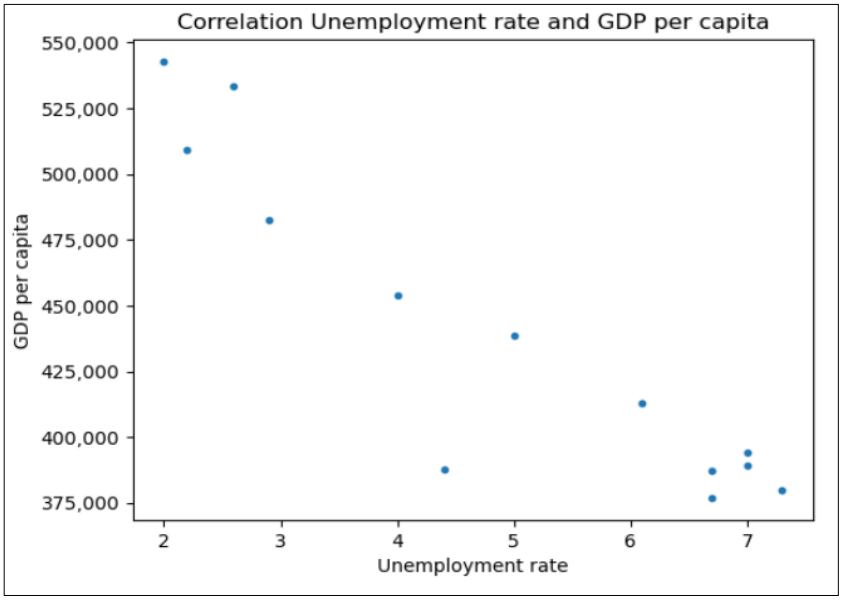

Figure 6. Correlation between unemployment rate and GDP per capita

The correlation between the unemployment rate and GDP is -0.924302, which indicates a very strong negative correlation, which can also be seen from the previous Figure 6. Thus, the unemployment rate is negatively correlated with all other investigated variables, the strongest correlation is with GDP.

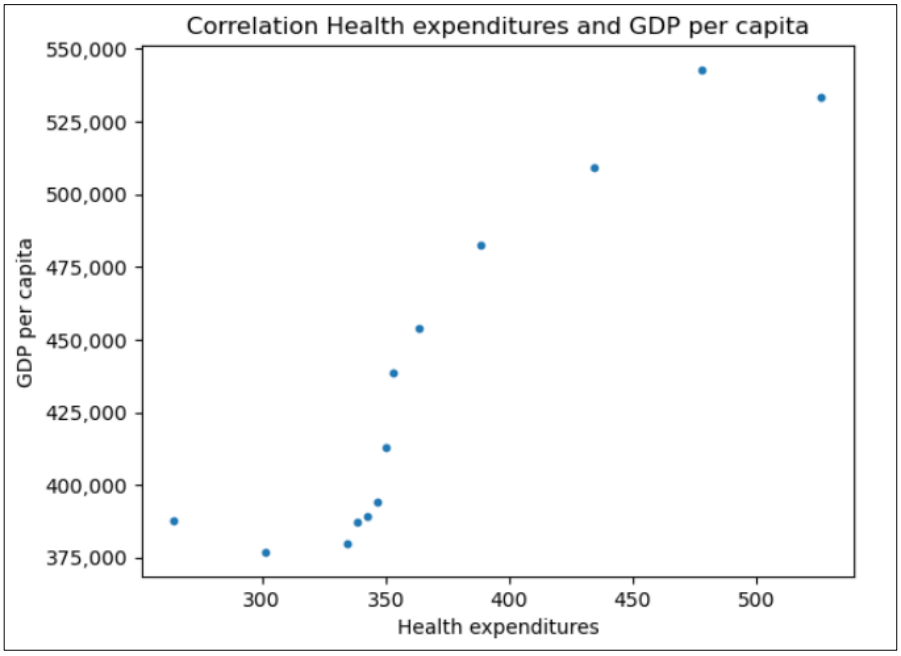

Figure 7. Correlation between health expenditures and GDP per capita

The correlation between health expenditure and GDP is 0.913980, which means a very strong positive correlation, as can be seen from Figure 7.

Thus, GDP has a very strong positive correlation with health care spending and a very strong negative correlation with the unemployment rate.

4. Discussion

Health expenditure is increasing substantially relative to gross domestic product (GDP) growth in almost all countries at all income levels (Mladenović et al., 2016). This increase in expenditure has become a major concern for governments and policymakers (Panopoulou & Pantelidis, 2012). Health expenditure has increased from 3% of global GDP in 1948 to 7.9% in 1997 (Self & Grabowski, 2003) to approximately 10% in 2014 (World Health Organization, 2016). Health expenditure is growing faster than GDP in numerous countries. (Rana et al., 2020). Currently, GDP growth is slower than health expenditures in many countries. This problem has been worsened by the Covid-19 pandemic, where healthcare expenditures have increased significantly. For example: The increase in healthcare expenditure directly related to the Covid-19 pandemic was equivalent to 2.0% of government health expenditure and 0.8 per thousand of gross domestic product (GDP) in Turkey in 2020 (Oksuz et al., 2021).

Hansen and Seo (2002) test the long-term relationship between real per-capita GDP and real per-capita healthcare expenditure in Japan. Tamakoshi and Hamori (2016) detect the presence of a threshold cointegrating relationship between the GDP and healthcare

expenditure. Further research may be focused on this long-term relationship in the Czech Republic.

5. Conclusions

By correlation analysis was shown, that GDP has a very strong positive correlation with healthcare spending and a very strong negative correlation with the unemployment rate. The correlation between the unemployment rate and healthcare expenditures is negative.

By time series modeling and predictions was shown, that prediction for healthcare expenditures is first a decrease and then a slight increase in the period until 2024.

Empirical findings on the relationship between healthcare expenses and gross domestic product (GDP) are diverse. (Rana et al., 2020)states that about 43 % of changes in the growth of global healthcare expenditure can be explained by economic growth. The study (Mladenović et al., 2016) also showed that an increase in healthcare expenditure is related to the level of income and economic growth of the country. Pandemic Covid-19 caused both the growth of healthcare expenditure and a decrease in GDP. Compared to commercial markets, individual governments are obliged to provide basic health care for free. Especially low-income countries and also a country with low GDP growth or high healthcare expenditure will have significant political and economic consequences (Král, 2022; Rana et al., 2020). According to the research (Bureš et al., 2016), it is also necessary to pay attention to the consequences of subjective perception of well-being and mental health, which will subsequently affect the use of health care.

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Targeted Application of the Work Design Questionnaire Using Self-Determination Theory to Generation Z

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Abstract: Questionnaire surveys measuring job satisfaction at the workplace are relatively very popular and widely used methods in most organizations. Experienced methods that are still used for the current working generations may not be so effective for the upcoming Generation Z. This generation is impatient, distracted, easily lose focus and patience, and dependent on digital technologies. The main goal of the article is therefore to identify the possibility of shortening the Work Design Questionnaire (WDQ), based on the use of sub-areas of self-determination theory (SDT) for the needs of generation Z. Furthermore, a comparison of whether filling in both versions of the questionnaire (standard and shortened according to the SDT) will have the same indicative value. The research is based on a quantitative questionnaire survey (n=395) and a statistical evaluation of the data. The quality of the questionnaires was verified by Cronbach's α and Confirmatory factor analysis. Both versions of the questionnaires were then compared at the level of sub-parts (autonomy, competence, relatedness) by comparing the average values of the recorded answers by Wilcoxon rank. The results indicate that the WDQ can be shortened in the areas of autonomy and competence, while in area relatedness this possibility has not been proven.

Keywords: Work Design Questionnaire; Self-determination theory; generation Z; job satisfaction, motivation

JEL Classification: M12; M54

1. Introduction

One of the most important tools for the comprehensive measurement of job satisfaction in the last few decades is the Work Design Questionnaire (WDQ). Morgeson and Humphrey (2006) summarized all the shortcomings of existing questionnaires (their over-generality or, conversely, their over-specificity) and created a new, compact, comprehensive questionnaire called WDQ. This tool has been validated in different contexts and countries, such as Germany (Stegmann et al., 2010), Brazil (Borges-Andrade et al., 2019), France (Bertolino et al., 2011), the Netherlands (Gorgievski-Duijvesteijn et al., 2016) and the Czech Republic (Procházka et al., 2020). The questionnaire aims to learn from the mistakes of previous questionnaires and to be a relevant method for measuring job characteristics and job satisfaction. The questionnaire identification resulted in 21 constructs, which were also

identified as factors of the WDQ method (Morgeson & Humphrey, 2006; Bayona et al., 2015; Fernández et al., 2017). However, this questionnaire is often criticized for its length (Marcus et al., 2007; Liu & Wronski, 2018). For completing the WDQ requires a significant time. This time span is estimated at 15 minutes and contains 77 items divided into 21 factors (Morgeson & Humphrey, 2006). Completing such a long questionnaire can easily lead to problems with measuring the quality of responses (Podsakoff et al., 2003). In practice, these effects can manifest as fatigue, which respondents may feel towards the end of completing the questionnaire, leading to consistent responses regardless of what the questions are about (Krosnick, 1999; MacKenzie & Podsakoff, 2012). As a result, conducting lengthy questionnaires against such a background may have an adverse effect on the quality and quantity of responses provided (Baumgartner & Steenkamp, 2001). And precisely its length can become a problem when applying it within the framework of testing Generation Z. These are people who were born between 1995 and 2009 (Berkup, 2014) and are therefore descendants of Generation X (Husák's children). Their perception of life is completely different from the perception of their parent's life perspective. Between these generations, there is a noticeable difference in the understanding of life satisfaction, as well as work satisfaction. Generation Z, unlike the previous generation and their parent's generation, places greater value on personal life, which they do not intend to sacrifice at the expense of work (Parment, 2013; Chillakuri, 2020). This generation is currently beginning to become economically active people. From the point of view of the employment relationship, they create most of those entering the labor market (Bennett et al., 2012). Concurrently their part in the labor market will increase yearly (ČSÚ, 2020). Kubátová (2016) lists the three most important work aspects of Generation Z, which are: opportunities for career growth, the need for more money and meaningful work. Their frequent requests are flexible working hours, part-time work, and the possibility to work from home or remotely online. Compared to previous generations, they have greater demands on employers, the work environment and the collective, especially a sense of personal fulfillment and motivation, which people previously did not place emphasized at all (Lissitsa & Kol, 2016). Generation Z has already been born into the digital world, they have no memory of life without access to the Internet (Reinikainen et al., 2020). For this reason, they take technology for granted, and all their activities or actions must correspond to the speed of the Internet. Therefore, all must be easy and fast (Van der Goot et al., 2016). Because they are versatile and broadly oriented, one of their main features is a reduced ability to pay constant attention, both in everyday life, at work, and on a concrete task or assignment (Ding et al., 2017; Poláková & Klímová, 2019). They are also impatient and prefer to get information quickly (Cruz, 2016).

The tool for solving the questionnaire length can be the Self-Determination Theory (SDT). Cross-sectionally, SDT coincides with this complex tool. The theory is represented by a set of several smaller theories where the main objective is to motivate people through the fulfillment of basic needs. (Buttitta et al., 2017; Chen et al., 2019; Deci & Ryan, 2000; Gyllison et al., 2008). Based on substantial research, autonomy, competence, and relatedness are considered universal, not dependent on age, origin, culture or gender (Chen et al., 2015). According to Deci and Ryan (2000), these are autonomy, competence, and relatedness, which

fully correspond with the core features of the WDQ questions (Humphrey et al., 2007). Criticism directed at the theory is most often in the form of focusing only on internal motivation, not on general motivation, as is the case with most authors (Gagné et al., 2015).

Developing a shorter instrument that is easier to administer and quicker to answer will contribute to improving the construct validity of the questionnaire. Also, improve the adequacy of the obtained data for subsequent analysis and interpretation. In this regard, it would seem appropriate to shorten the WDQ to facilitate its future use (Marcus et al., 2007; Liu & Wronski, 2018). Therefore, a shortening of the questionnaire based on SDT is proposed, by the main three pillars of human motivation are autonomy, competence, and relatedness (Ryan & Deci, 2006).

The aim of the study is to identify the possibility of shortening the WDQ, based on the use of sub-areas of SDT for the needs of generation Z. The study will use 8 factors for the truncated version of the questionnaire, which contains 31 items, instead of the original ones in the original wording of the questionnaire 21 factors and 77 items. These are especially those factors/items that describe the SDT and its essence, so these are items that deal with the areas of autonomy, competence and relatedness.

2. Methodology

The research described in this study was based on a questionnaire survey. Data collection was carried out in a selective manner. The method used was the WDQ questionnaire measuring job satisfaction, which is standardized and translated into the Czech language (Procházka et al., 2020). The WDQ questionnaire measures job satisfaction on a 5-point standardized scale in the form of "strongly disagree", "disagree", "don't know", "agree", and "strongly agree". Two versions of the WDQ questionnaire were compared in order to verify the mutually equal indicative value of the responses of the results. The classic long (standard version) and the shortened version, which is based on SDT theory. Each respondent completed the full (standard) version of the questionnaire. Answers for the short version of the questionnaire were extracted from the standard long version, based on the agreement of the list of required factors with SDT theory. These questions focus on issues related to autonomy, competence, and relatedness. For the abbreviated version of the autonomy research (Section A), only three factors (F1, F2, F3) were used instead of the original seven factors. These three selected factors contain 9 items (WDQ_1, WDQ_2, WDQ_3, WDQ_4, WDQ_5, WDQ_6, WDQ_7, WDQ_8, WDQ_9) which clearly relate to the area of autonomy. The selection of questions from the field of competence (section B) took place according to Kane (1992), in problem solving, the composition of the diversity of skills and specialization. This area is represented by three factors (F10, F11, F12), instead of the original five factors. They contain 12 items (WDQ_{33}, WDQ_{34}, WDQ_{35}, WDQ_{36}, WDQ_{37}, WDQ_{38}, WDQ_{39}, WDQ_{40}, WDQ_{41}, WDQ_{42}, WDQ_{43}, WDQ_{44}). The relatedness factor (section C) was selected from the WDQ questionnaire based on the social factor according to Granzier et al. (2021) in the form of two factors (F13, F16) from the original five factors. These are social support and cooperation outside the organization and are represented by 10 items (WDQ_{45}, WDQ_{46}, WDQ_{47}, WDQ_{48}, WDQ_{49}, WDQ_{50}, WDQ_{57}, WDQ_{58}, WDQ_{59}, WDQ_{60}). Out of a total 21 factors that are included in the

standard scope of the questionnaire, the above-mentioned eight factors were selected, which have 31 items. The selection of factors, and thus also the items of the WDQ questionnaire, is based on satisfactory researched areas that significantly coincide with the elements of the SDT theory and at the same time with a targeted shortening of the questionnaire (Marcus et al., 2007; Liu & Wronski, 2018).

The research population consisted of 395 respondents from Generation Z, active students or graduates of the Czech University of Life Sciences Prague. Addressing the graduates was conditional on their date of graduation, in order to the respondent belong completely into generation Z. Their belonging to Generation Z was verified in the second phase, where all respondents were asked about their year of birth as part of a questionnaire survey.The data for this study were collected from employees working in various sectors, regardless of their length of employment in the given organization or the scope of their employment. The employees were contacted by e-mail, where they were initially informed about the purpose of the survey, including the form of the questionnaire and a brief introduction to the issue. The LimeSurvey online application (LimeSurvey, 2020) was chosen for the survey. Data were collected between March 2020 and May 2020. IBM SPSS Statistics (IBM, 2022) and Jamovi (Jamovi, 2020) software were used to test the predicted outcome.

Cronbach's α statistical method was used to initially determine whether the entire WDQ questionnaire and its shortened version have a sufficient degree of internal consistency and reliability. Conformational factor analysis verified the validity of the questionnaires, and whether the questionnaires were used correctly. The aim of the study is to find out whether the long and short versions of the questionnaires work the same. Based on the findings, the long version of the questionnaire can be replaced by a short version, from which the following hypothesis, which are intended for each section separately follows:

- H_{0A}: The average values of the answers in the section A of the questionnaire do not differ between the short and long versions.
- H_{1A}: The average values of the answers in the section A of the questionnaire differ between the short and long versions.
- H_{0B}: The average values of the answers in the section B of the questionnaire do not differ between the short and long versions.
- H_{1B}: The average values of the answers in the section B of the questionnaire differ between the short and long versions.
- H_{0C}: The average values of the answers in the section C of the questionnaire do not differ between the short and long versions.
- H_{1C}: The average values of the answers in the section C of the questionnaire differ between the short and long versions.

The hypothesis was evaluated at 5% significance. The normal distribution of the data was tested using the normality test (Shapiro-Wilk test). Based on the results of normality Wilcoxon rank was subsequently used for testing differences.

3. Results

3.1. Section A

Based on the Crombach α test, an adequate degree of internal consistency and reliability was demonstrated for both questionnaires. For the short version the scale was 0.847, and for the long version 0.836. As evident from Table 1, the confirmatory factor analysis confirms the factors with an adequate degree of internal consistency and reliability (*p*–value = <0.001). At the same time, the RMSEA value (0.0384) indicates a very good quality of the long version of the questionnaire. The questionnaire is therefore in order from the point of reliability and psychometric properties.

Table 1. Confirmatory Factor Analysis for section A

Factor	Indicator	Estimate	SE	Z	*p*
Factor 1	WDQ $_{1}$	0.693	0.0492	14.08	< .001
	WDQ $_{2}$	0.798	0.0513	15.56	< .001
	WDQ $_{3}$	0.748	0.0498	15.02	< .001
Factor 2	WDQ $_{4}$	0.663	0.0491	13.51	< .001
	WDQ $_{5}$	0.734	0.0489	15.01	< .001
	WDQ $_{6}$	0.752	0.0477	15.78	< .001
Factor 3	WDQ $_{7}$	0.692	0.0560	12.34	< .001
	WDQ $_{8}$	0.844	0.0524	16.09	< .001
	WDQ $_{9}$	0.774	0.0508	15.23	< .001
Factor 4	WDQ $_{10}$	0.823	0.0486	16.93	< .001
	WDQ $_{11}$	0.881	0.0457	19.29	< .001
	WDQ $_{12}$	0.963	0.0471	20.44	< .001
	WDQ $_{13}$	0.898	0.0441	20.35	< .001
Factor 5	WDQ $_{14}$	0.844	0.0615	13.72	< .001
	WDQ $_{15}$	0.879	0.0489	17.97	< .001
	WDQ $_{16}$	0.798	0.0491	16.24	< .001
	WDQ $_{17}$	0.711	0.0574	12.40	< .001
Factor 6	WDQ $_{18}$	0.440	0.0593	7.42	< .001
	WDQ $_{19}$	0.712	0.0512	13.90	< .001
	WDQ $_{20}$	0.851	0.0466	18.28	< .001
	WDQ $_{21}$	0.782	0.0435	17.95	< .001
Factor 7	WDQ $_{22}$	0.648	0.0492	13.16	< .001
	WDQ $_{23}$	0.802	0.0484	16.58	< .001
	WDQ $_{24}$	0.804	0.0463	17.35	< .001

The established hypotheses (H0A and H1A) were verified based on the process of partial following steps, see Table 2. A normality test (Shapiro-Wilk) revealed that the data did not have a normal distribution (p-value = <0.001). Therefore, the Wilcoxon rank was subsequently used, which, based on the resulting value, confirmed that the averages of both versions of the questionnaire are the same (p-value = 0.166), therefore H0A at the 5% level of significance is accepted.

Table 2. Descriptive statistics and Paired Samples T-Test for section A

	Short version (A)	Long version (A)
Mean	3.61	3.59
Median	3.67	3.58
Standard deviation	0.695	0.485
Shapiro-Wilk *W*	0.984	0.984
Shapiro-Wilk *p*	< .001	< .001
Wilcoxon *W*	*0.166*	

3.2. Section B

Both, the short and long versions of the questionnaires have an adequate degree of internal consistency and reliability. Crombach's α for the short version is 0.885 and for the long version is 0.804. Table 3 below shows, the confirmatory factor analysis confirms this statement (*p*-value = <0.001). The very good quality of the long version of the questionnaire is supported by the RMSEA value of 0.0807. The questionnaire is therefore in order from the point of reliability and psychometric properties.

Table 3. Confirmatory Factor Analysis for section B

Factor	Indicator	Estimate	SE	Z	*p*
Factor 1	WDQ $_{25}$	0.250	0.0638	3.92	< .001
	WDQ $_{26}$	1.056	0.0481	21.97	< .001
	WDQ $_{27}$	1.053	0.0485	21.70	< .001
	WDQ $_{28}$	0.926	0.0513	18.05	< .001
Factor 2	WDQ $_{29}$	0.788	0.0506	15.56	< .001
	WDQ $_{30}$	0.790	0.0505	15.63	< .001
	WDQ $_{31}$	0.507	0.0481	10.53	< .001
	WDQ $_{32}$	0.923	0.0525	17.59	< .001
Factor 3	WDQ $_{33}$	0.592	0.0613	9.66	< .001
	WDQ $_{34}$	0.964	0.0578	16.67	< .001
	WDQ $_{35}$	0.589	0.0546	10.77	< .001
	WDQ $_{36}$	1.035	0.0539	19.20	< .001
Factor 4	WDQ $_{37}$	0.695	0.0487	14.28	< .001
	WDQ $_{38}$	0.843	0.0483	17.45	< .001
	WDQ $_{39}$	0.887	0.0556	15.96	< .001
	WDQ $_{40}$	0.995	0.0478	20.82	< .001
Factor 5	WDQ $_{41}$	0.956	0.0517	18.48	< .001
	WDQ $_{42}$	0.926	0.0514	18.01	< .001
	WDQ $_{43}$	1.084	0.0484	22.40	< .001
	WDQ $_{44}$	1.001	0.0532	18.80	< .001

The established hypotheses (H0B and H1B) were verified based on the process of partial following steps, see Table 4. The normality test (Shapiro-Wilk) indicates that the data of the short version of the questionnaire does not have a normal distribution (p-value = 0.028). The long version of the questionnaire has a normal data distribution. Because the result for the short version indicates that the data do not have a normal distribution, the Wilcoxon rank was subsequently used. The test result indicates that the averages of both questionnaires are the same (p-value = 0.840), therefore H0B at the 5% level of significance is accepted.

Table 4. Descriptive statistics and Paired Samples T-Test for section B

	Short version (B)	Long version (B)
Mean	3.23	3.24
Median	3.25	3.25
Standard deviation	0.777	0.531
Shapiro-Wilk *W*	0.992	0.994
Shapiro-Wilk *p*	0.028	0.117
Wilcoxon *W*	*0.840*	

3.3. Section C

The short version of the questionnaire gives a value of Crombach's α of 0.764, and the long version of 0.777. Both versions have an adequate degree of internal consistency and reliability, which was confirmed by Confirmatory Factor Analysis (*p*-value = <0.001), as can be seen from Table 5 below. The very good quality of the questionnaire is indicated by the RMSEA value of 0.0897. The questionnaire is therefore in order from the point of reliability and psychometric properties.

Table 5. Confirmatory Factor Analysis for section C

Factor	Indicator	Estimate	SE	Z	*p*
Factor 1	WDQ $_{45}$	0.617	0.0493	12.52	< .001
	WDQ $_{46}$	0.471	0.0543	8.67	< .001
	WDQ $_{47}$	0.519	0.0581	8.94	< .001
	WDQ $_{48}$	0.666	0.0569	11.71	< .001
	WDQ $_{49}$	0.716	0.0463	15.47	< .001
	WDQ $_{50}$	0.609	0.0426	14.29	< .001
Factor 2	WDQ $_{51}$	0.727	0.0502	14.49	< .001
	WDQ $_{52}$	0.942	0.0580	16.23	< .001
	WDQ $_{53}$	1.029	0.0553	18.60	< .001
Factor 3	WDQ $_{54}$	0.721	0.0545	13.21	< .001
	WDQ $_{55}$	0.927	0.0558	16.62	< .001
	WDQ $_{56}$	0.898	0.0592	15.16	< .001
Factor 4	WDQ $_{57}$	0.618	0.0621	9.95	< .001
	WDQ $_{58}$	0.967	0.0597	16.19	< .001
	WDQ $_{59}$	1.053	0.0556	18.92	< .001
	WDQ $_{60}$	1.133	0.0556	20.38	< .001
Factor 5	WDQ $_{61}$	0.881	0.0496	17.78	< .001
	WDQ $_{62}$	0.893	0.0487	18.34	< .001
	WDQ $_{63}$	0.852	0.0460	18.54	< .001

The established hypotheses (H0C and H1C) were verified based on the process of partial following steps, see Table 6. The normality test (Shapiro-Wilk) indicates that the data of the short version of the questionnaire does not have a normal distribution (p-value = 0.001). The long version of the questionnaire has a normal data distribution. Based on the non-normal distribution of the data in the short version, the Wilcoxon rank was used. The result indicates that the averages of both questionnaires are not the same (p-value = <0.001), therefore H0C at the 5% level of significance is rejected.

Table 6. Descriptive statistics and Paired Samples T-Test for section C

	Short version (C)	Long version (C)
Mean	3.64	3.36
Median	3.70	3.37
Standard deviation	0.624	0.499
Shapiro-Wilk *W*	0.987	0.996
Shapiro-Wilk *p*	0 .001	0.324
Wilcoxon *W*	*< .001*	

4. Discussion

The standard length of the WDQ questionnaire is set at 21 factors, which include 77 items (Morgeson & Humphrey, 2006). The length of time to complete it is estimated at 15 minutes (Morgeson & Humphrey, 2006), which, assuming it is aimed at the Baby Boomers, X or Y would seem to be perfectly fine (Bayona et al., 2015), not with Generation Z. Marcus et al. (2007) add that the aforementioned scope of the WDQ questionnaire is nowadays and completely inappropriate in relation to younger generations, and they recommend shortening it to the most important aspects related to job satisfaction. Research by Liu and Wronski (2018) showed that the unnecessary length of questionnaire surveys could have a negative effect on younger generations of the adequacy of data sample collection. One of the main features of members of Generation Z is a reduced ability to pay constant attention (Ding et al., 2017; Poláková & Klímová, 2019). This generation wants to have everything fast and now (Reinikainen et al., 2020). At the same time, they are also impatient and prefer quick information acquisition (Cruz, 2016). The SDT theory focuses on a person's internal motivation, which is greatly intertwined with work motivation. Based on SDT theory, this study tested the possibility of truncation by area of autonomy, competence, and relatedness (Legault et al., 2017; Greguras et al., 2014; Gatling et al., 2016). The formulation of SDT theory is rooted in the second half of the 20th century (Ryan & Deci, 2017; 2020). The research shows that even though this generation was not yet born at the time of the formulation of this theory, the reach and influence of the relatively old theory persists even today in various areas as. Artificial Intelligence (Xia et al., 2022), Education (Hosseini et al., 2022; Liu & Oga-Baldwin, 2022; Banerjee & Halder, 2021), Entrepreneurship (Bilal et al., 2021; Nazir et al., 2021), medicine (Duprez et al., 2021; Grønnegaard et al., 2020), travel-tourism (Buzinde, 2020) and many others. The proof is also the results of this research, applied to the WDQ questionnaire in sections A and B. By shortening the standard version of the questionnaire to a short version, it was possible to reveal that the questions included in the short version of the questionnaire carry the most important information. According to the aforementioned results, the questions that were purposefully omitted based on the possible shortening of the questionnaire are insignificant in the context of the targeted use of the questionnaire on generation Z. Specific questions that were not selected for the shortened version according to the SDT theory, do not even fit into the needs of generation Z according by Kubátová (2016), who claims that the priority for Generation Z is career growth, the need for money and meaningful work. The results obtained in the area of section C do not allow the questionnaire to be shortened according to the SDT theory. On the basis of the conducted tests, the central

importance of all the questions found in the long questionnaire in the field of social factors was proven. For generation Z, in the field of social characteristics, all sub-aspects are important, which are friends at the workplace, support in them, the interdependence of work with other colleagues, contact with them, and their interests. They also include cooperation outside the organization and feedback from colleagues. These results from specific areas such as making friends, contact with coworkers, and common interests with coworkers, provide some clarification compared to the inconsistent findings of previous research (Campione, 2015; Ng et al., 2010; Twenge, 2010).

Section C of the WDQ presents an opportunity for further possible research. The effort to shorten section C according to the SDT was unsuccessful because it was proven that all questions located in area C carry key information. The direction of future research could be towards a different theory, for example, Vroom's expectancy theory (Vroom, 1964; Marriner-Tomey, 2004), McClelland's theory (Harrell & Stahl, 1984), ERG theory (Aldefer, 1969). Or a theory that specifically deals only with social characteristics, according to which there could be an attempt to shorten section C. Another direction could be to find out whether, even for generations X and Y, it could come up with a proposal to shorten the questionnaire, and thereby support the theory that these generations are very different, or, on the contrary, disprove the theory.

A limitation of the research can be found in the size of the sample. Although the sample of 395 respondents can be considered representative, larger participation, and even more respondents would offer a greater informative value of the research. Limitations can also be found in possible inappropriate filling in of the questionnaire by some respondents. Assuming that the respondent was for example under stress, or for some other reason unable to adequately fill out the questionnaire. Although the survey was conducted in 2020, the results can still be considered current. At the time of publication of the results, no study was found that addressed the shortening of the WDQ questionnaire.

5. Conclusions

The study dealt with the identification of the possibility of shortening the WDQ questionnaire, based on the use of sub-areas of the SDT for the needs of generation Z. 395 respondents, residents of the Czech Republic born after 1995, were subjected to participation in the questionnaire survey. Respondents filled out the WDQ questionnaire with a standard range of 77 items, from which a second variant with a range of 31 items was extracted.

The results indicate that the WDQ questionnaire can be recommended for shortening in the area of autonomy (H_{0A}) and competence (H_{0B}). A relatedness section (H_{1C}) is not recommended for shortening. The Wilcoxon rank clearly confirms the different averages of the two questionnaires. All the questions included in section C are important and carry significant information.

The advantages of applying the shorter version of the questionnaire clearly outweigh any minimal risks. The most significant advantage of using a shorter version of the questionnaire survey is obtaining high-quality answers from respondents that will not be influenced or distorted by their fatigue or distraction.

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Critical Discursive Psychology of Informal Learning in an SME Coworking Space in Kuwait

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Abstract: The aim of this study is to explore informal learning practices among full-time office personnel at an SME coworking space in Kuwait and the ways in which they acquire new skills and knowledge. Using a critical discursive psychological approach, data collected through three semi-structured interviews were analyzed. The findings reveal the existence of four distinct interpretive repertoires of informal learning, each with its own unique characteristics, purpose and individual's role within the organization. Additionally, the research illustrates how the unique characteristics of the coworking industry and the SME context in Kuwait shape these informal learning practices. This research fills a gap in knowledge on informal learning in SMEs and specifically addresses the limited research on this topic in an international setting, providing valuable insights for businesses, policymakers, and researchers alike.

Keywords: human resource development; informal learning; small and medium-sized enterprise; identity

JEL Classification: M12; M13; M50

1. Introduction

Small and medium-sized enterprises (SMEs) are numerically a strong segment of the economy and dominant contributors to employment across countries at different stages of development, and as such, account for a substantial part of the workplace-learning context (OECD, 2017; Coetzer, Wallo, & Kock, 2019; Coetzer, Kock, & Wallo, 2017). In Kuwait, it is estimated that SMEs make up about 90% of the total number of privately held companies (MARKAZ, 2020). The benefits of informal learning for both organizations and individuals are widely acknowledged in human resource development (HRD) literature, with research showing its positive impact on organizational performance, competitiveness, and employee productivity and employability (Atkinson, Lupton, Kynighou, & Antcliff, 2021; Susomrith & Coetzer, 2019; Zuo, Fisher, & Yang, 2019; Zhang & Edgar, 2021; Donohue & Tham, 2019; Jeong, McLean, & Park, 2018).

Informal learning encompasses a wide range of practices that occur outside of formal classroom or structured learning environments (Marisck & Watkins, 1990). According to Kim & McLean (2014), major factors that influence informal learning can be categorised into three levels: individual, peer-to-peer, organisational and environmental. Individual level factors include trial-and-error and self-directed learning, where individuals identify their own

learning goals, methods, and resources (Lemmetty & Collin, 2020). Peer-to-peer level includes, for example, coaching and mentoring (Mentz & Zyl, 2018; Wolff, Stojan, Buckler, Cranford, Whitman, Gruppen, & Santen, 2019). Organisational/environmental level factors include HR systems (Kim & McLean, 2014). While informal learning has the potential to increase autonomy (Lemmetty & Collin, 2020), it is also shaped by contextual factors such as industry discourses, and social constructions of meaning (Garrick, 1998). Understanding how informal learning is influenced by these contextual factors can help to comprehend the complexity of workplace learning in a specific environment.

Although informal learning has been widely studied (e.g. Crans, Bude, Beausaert, & Segers; 2021; Marsick & Watkins, 1990), there is a lack of research on this topic in the context of SMEs (Coetzer et al., 2017; Coetzer et al., 2019; Jeong et al., 2018), particularly in international settings where individuals of different national origins may have different reactions to management practices in these organizations (Kim & McLean, 2014; Jeong et al., 2018). The HRD literature on workplace learning is primarily based on research in large organizations, leaving a gap in our understanding of learning practices in SMEs (Coetzer et al., 2017; Coetzer et al., 2019). However, SMEs have distinct learning needs and resources and often challenges such as financial constraints, limited managerial capacity, high levels of procedural informality, and a lack of human resources that can impact effective learning initiatives (Coetzer et al., 2017; Coetzer et al., 2019; Psychogios et al., 2019). Therefore, it is important to examine SMEs' specific learning practices, in order to understand how they can effectively support the learning and development of their personnel.

This study aims to explore informal learning among personnel in an SME coworking space in Kuwait. Coworking spaces provide office space, and shared administrative and support services to SMEs, freelancers, and other independent professionals (Orel & Dvoulety, 2020), and foster peer collaboration and skills exchange, creating opportunities for informal learning through the creation of ready-made communities of practice (Bilandzic, Schroeter, & Foth, 2013). In Kuwait, coworking spaces have gained popularity as a solution to the increasing cost of office space. Although earlier research on cowering spaces focused the role of human talent (Orel, Mayerhoffer, & Fratricova, 2022) and knowledge exchange processes among users (Bouncken & Aslam, 2019), studies on the topic of personnel workplace learning in these hybrid spaces (Orel & Dvoulety, 2020) are scarce.

To address this gap, this study employs critical discursive psychology (CDP), a prominent approach from within the broad disciplinary area of discourse analysis (Taylor, 2001). CDP allows researchers to examine the situated nature of language use (Garrick, 1998). This is particularly relevant for studying informal learning in a coworking SME in Kuwait, as it allows researchers to understand how the cultural and social context of the organization shapes learning practices. Overall, CDP offers a rich approach for studying informal learning in SMEs in Kuwait, allowing researchers to examine the situated nature of language use (Garrick, 1998) and the discursive resources that individuals utilize when constructing their views and identities (Horton-Salway, 2007).

Thus, the study asks: How do employees of an SME coworking space in Kuwait describe the practice of informal learning?

This study aims to deepen our understanding of HRD in SMEs and provide valuable insights for practitioners looking to facilitate informal learning.

2. Methodology

This research adopts a post-structuralist perspective and asserts that knowledge is positioned, incomplete, and comparative (Taylor, 2001). These epistemological claims are particularly relevant in the context of qualitative research (Holloway, 2007). From a post-structuralist perspective, it is important to examine the modes of speech and discourses that individuals use to construct their views in the context of workplace learning research (Lemmetty & Collin, 2020). Using self-narratives can provide insight into the culturally accessible repertoires that individuals utilize when discussing workplace learning. According to Rhodes and Brown (2005), the investigation and analysis of narratives that participants create about their groups, departments, and organizations can lead to a more nuanced understanding of working lives. By altering the direction of certain narratives, a positive outcome in an employment relationship can be achieved (Conway & Briner, 2005).

The purpose of this research was to explore the different ways of talking about informal learning that are employed in order to increase understanding of the various aspects and nature of workplace learning in SMEs. CDP, which focuses on the way language is used to construct social reality, can be used to examine the action orientation of talk (Taylor, 2001; Wetherell, Taylor, & Yates, 2001). It combines insights from post-structuralist and Foucauldian-influenced notions of discourse with those from the ethnomethodological/conversation tradition (Wetherell, 1998). This allows for both a top-down view, paying attention to discourse resources and how widely accepted cultural representations impact the expression of assertions, and a bottom-up perspective, focusing on discourse processes and how language constructs social order (Wetherell, 1998).

2.1. Research Context

The study was conducted at a profit-based coworking space provider, named Nomad (pseudonym), located in Kuwait. Founded in 2018, Nomad is a leading coworking space provider in Kuwait and is considered an SME with 0-249 employees and an annual turnover of less than 5 million Kuwaiti Dinars (UNDP, 2011). To ensure its continued economic sustainability, Nomad established an incubation program within its coworking space to support small businesses at different stages of development, expanding both its network and that of the small businesses.

This study conducted three semi-structured interviews with full-time office personnel. The choice to focus on full-time employees was made as they are more likely to be fully integrated into the organization's social system (Gakovic & Tetrick, 2003), compared to other employees, like baristas, mandoob (delegate), and external

mentors/coaches. The management of human resources is shared by the owner-manager and accountant/HR executive, and centers primarily on legal and payroll matters respectively. The 60-minute interviews were conducted in November 2021, recorded, transcribed, and analyzed, and the participants were proficient in English. To protect anonymity and confidentiality, pseudonyms were used. The researcher familiarized herself with the organization by visiting the participating firm prior to conducting the interviews and observing the daily activities of the personnel. The interviews focused on workplace learning and competence development, with questions such as 'Can you share your opinion on learning in the workplace?', 'How do you go about improving your skills and abilities at work?', and 'How does your employer support the development of your competencies in the workplace?' Table 1 provides an overview of the participant characteristics employed in this study.

Table 1. Interviewees of the study

Alias	Primary job role	Years with Nomad	Education level	Age
Fatmah	Community coordinator	2 years	Bachelor's degree	24
Abdullah	SME specialist	2 years	Bachelor's degree	27
Vimal	Accountant/HR Executive	2 years	Bachelor's degree	26

2.2. Analysis

The current study used critical discursive psychological methods and tools to uncover patterns in the sample. The analysis was guided by three key concepts in CDP: interpretative repertoires, subject positions, and ideological dilemmas (Edley, 2001). *Interpretative repertoires* are concerned with discourse processes (Horton-Salway, 2007). They have been described as a register of terms, figures of speech (tropes), and metaphors that help evaluate events and actions (Potter & Wetherell, 1987). Edley (2001, p.198) described interpretive repertoires as 'the building blocks of conversation'. *Subject positions,* or ways of being, represent culturally accessible kinds (discourse resources) that characterize individuals and their identities (Horton-Salway, 2007). From this top-down perspective, subject positions are already present in discourse but can change in relation to historical and cultural circumstances (Horton-Salway, 2007). Social identities are therefore to some extent characterized by the prior discourses (and accessible subject positions) of contemporary cultures (Horton-Salway, 2007). Workplaces are a site for the circulation of multiple discourses, which generate different subject positions and ways of being (Harman, 2011). In this sense, identities are flexible and in process (Horton-Salway, 2007). Subject positions link the concept of interpretative repertoires to the social construction of specific identities (Edley, 2001). Finally, since shared understanding is full of counter-arguments, daily discourse can be '*dilemmatic*' (Billig et al., 1988, p. 22).

3. Results

In this study, I identified four interpretive repertoires with distinct perspectives on informal learning, individual roles, and the learning environment. Participants adopted different, and sometimes contradictory, subject positions and navigated various ideological dilemmas, which were shaped by a range of factors, including the participant's personal experiences, organizational culture, and the broader discourses of the coworking industry.

Next, I will provide an overview of these four interpretive repertoires, subject position and ideological dilemmas, highlighting the key characteristics of each and the ways in which they shape our understanding of informal learning in the workplace. These perspectives are not exhaustive and are meant to provide a general understanding of the findings of the study.

3.1. Interpretative Repertoires, Subject Positions and Ideological Dilemmas

At Nomad, formal training is not a dominant discursive resource of the company and learning was primarily self-initiated. However, participants rely (at times) on various informal learning discursive resources to support their informal learning process.

Fast-paced and flexible practice. At Nomad, the fast and flexible learning repertoire reflects the dynamic nature of SMEs and coworking industry in Kuwait, as well as Kuwait's competitive landscape. This repertoire involves juggling a broad range of work responsibilities and managing several tasks efficiently, with the customer and his or her needs playing a central role in the interpretative repertoire. Phrases that suggested shared repertoires around this topic included 'haste', 'little time to think', and 'customer requirements'. Participants adopted the subject position of a flexible learner constructing flexibility as an organizational requirement and an internalized quality (Lindell, Popover & Uhlin, 2022), as is seen in the following fragment:

Fatmah: With this position, it always makes me feel like I'm in a hurry. Because I handle a lot, I try to learn things quickly because new things are going to come.

This involves the ability to rapidly adapt and respond to the fast-paced work environment by being open to learning new skills to meet the demands of the job. The learning process in this context often happens spontaneously as a response to a new task or situation, but the lack of clear organizational structures, such as policies and rules, can hinder employees' learning opportunities. The absence of these structures can result in a reactive approach to learning (Watkins & Marsick, 1992) where individuals are only able to manage challenges they face in their daily work.

An ideological dilemma in the fast-paced and flexible learning repertoire at Nomad is the tension between the benefits of flexibility for employees and the lack of structure (Lindell et al., 2022), which is seen in the following fragment:

Abdullah: I think in my day-to-day activities are stopping me from reaching their (note by the author: international incubators or business accelerators from 500 Startups) standards because I'm busy with day-to-day work … so I'm focused on getting things done on a daily basis... Because of business on this side I'm not able to reach their way of work.

A post-structuralist reading suggests that the idea of 'becoming more flexible' in a fast-paced business environment might be a subtle way of asking employees to take on more responsibilities without receiving any extra pay (Garrick, 1998).

Learning as entrepreneurial practice. The coworking space at Nomad, with its distinct entrepreneurial atmosphere, fostered a discourse of entrepreneurship (Ivanova & von Scheve, 2019) that encouraged participants to undertake new and challenging activities such as organizing seminars and participating in the creation of programs for Nomad's clients. The interpretative repertoire around entrepreneurship is positively oriented, with all respondents viewing change as offering opportunities for creativity and growth. Indeed, the terms employed in this repertoire suggested the notion of progress, from 'proactive' to 'improvement'. This is evident in the following fragment:

Abdullah: Being part of the program was a huge learning experience for me... things I haven't even learned in university.

This discourse positioned employees as enterprising selves (Fournier, 1998) and active agents in their own learning process. This can be seen in the following fragments:

Abdullah: If there's something that can add value to me, I definitely do it.

Fatmah: I want to be a better person in everything. Here, everyone is a manager for himself.

The findings indicate that the sense of empowerment among employees at Nomad is shaped by their relationships with the owner-manager (Grieves, 2003), who often '*pushes'* (Vimal) them to strive for more. This entrepreneurial discourse aims to give workers greater decision-making responsibility (Mir & Mir, 2005), in exchange for their cooperation (Garrick, 1998). As a result, employees are expected to self-manage their work and time (Ivanova & von Scheve, 2019).

However, this practice also presents an ideological dilemma, balancing the benefits of empowerment and autonomy as an enterprising self (Fournier, 1998) and avoiding overburdening of employees (Garrick, 1998). The following fragment indicates realisation that although Nomad proves an excellent learning opportunity, it is profit-driven and 'lean', which leaves Vimal overburdened with excessive workload:

Vimal: I think that's the thing with startups…. you get so many positions that you get to learn everything… And… there are side effects. Like getting exhausted. Tasks you couldn't finish.

Learning as collaborative practice. The learning as collaborative practice emphasizes close working relationships, the close-knit and supportive atmosphere, and the sharing of knowledge, all of which motivate employees to engage in continuous learning. Collaborating with colleagues and other companies on important projects was mentioned as a way for participants to learn:

Abdullah: We work as a team, especially when we're facing a problem and we usually meet up to do it. And we also do it with other companies. Nomad has a program, which we do once a year, it's called xxxx program (name of the program removed by the author to maintain company's anonymity) where we develop different businesses. During this program we do group work, we kind of exchange knowledge with each other.

The subject position of collaborator was adopted by the participants at Nomad through their close working relationships with their colleagues to share ideas, best practices, and work on

challenging projects. This collaborative approach to learning enabled the employees to overcome disciplinary barriers, solve problems and work more efficiently on challenging projects. These learning activities, characterized by mutual exchanges, frequently take place on a group level and involve activities such as sharing knowledge, debriefing, and exchanging feedback.

However, an ideological dilemma arises when considering the potential tension between the benefits of collaboration, such as innovation (Mentz & Zyl, 2018), and the use of 'family' discourse used to shape behavior through loyalty appeals (Garrick, 1998), potentially compromising the autonomy of employees (Garrick, 1998).

Practice tied to networking. Another linguistic repertoire present was in reference to networking. This repertoire included the *internal network*, which included colleagues and the owner-manager. The participants' repertoires connected networking with 'interaction' , 'exchanging', and 'personal and professional growth'. Participants' adoption of the learner subject position, however, was contingent on the status of the person they were seeking expertise from. From within the internal network, they were more likely to seek information or help from individuals with higher status, such as the owner-manager or more experienced colleagues, which is seen in the following fragment:

Abdullah: The person I'm learning the most from is Mustafa (note by the author: the owner-manager) because of the way he thinks. He doesn't think locally, he thinks internationally.

Similarly, Fatmah narrates that the person she mostly learns from is the owner-manager because of his *'experience.. and what he reached according to his age is huge'*.

My findings also highlight the presence of power dynamics in the *external network* at Nomad, which comprises clients, tenants, external mentors and coaches, and members. In Fatmah's case, she leveraged these external connections to broaden her knowledge beyond her immediate job role, gaining valuable insights from well-educated and culturally diverse individuals.

While Fatmah adopted a more passive subject position in learning characterised by her acceptance of the local market dynamics and preference for traditional knowledge sources in the given context, Abdullah believes that his learning would be better facilitated by working with international mentors in addition to local ones:

Abdullah: There's a ceiling to my learning because of the kind of mentors I have. My learning would be better facilitated by working with international startups, by meeting international mentors and not just local mentors … who have a local mindset.

Abdullah also characterizes Nomad as being configured to local market dynamics (Orel & Dvoulety, 2020), which he believes limits his learning. Based on his comments about the limitations of the local network and the value of international mentors, I will argue Abdullah has adopted the subject position of an advocate, advocating for the importance of expanding the network beyond the local context in order to enhance learning. As the most senior employee at Nomad, it could be argued that Abdullah has developed a critical eye for evaluating the quality of different sources of information.

However, Abdullah's perspective also raises an ideological dilemma, as it suggests that learning is perceived as more valuable when it extends beyond local sources. This idea may stem from broader discourses of globalization and the belief that international experiences are inherently superior, and it may also mirror a lack of confidence in local learning opportunities.

4. Discussion

In the current study, I examined how employees at an SME coworking space provider in Kuwait describe the practice of informal learning in the context of workplace learning. My research findings indicate the existence of four distinct interpretive repertoires of informal learning, each with its own unique characteristics, purpose and individual's role within the organization. These interpretive repertoires included a focus on a fast-paced and flexible learning, entrepreneurial endeavors, networking, and collaborative learning.

This study confirms previous research on SMEs, which has shown that formal training opportunities are limited (Coetzer et al., 2019). At Nomad, it was found that employees primarily rely on informal channels for learning and development. This is in line with the widely accepted notion that informal learning is the most common mode of workplace learning (Kim & McLean, 2014). The results of this study further indicate that Nomad's employees depend on learning that is closely linked to their work (Lemmetty & Collin, 2020).

My study further shows that the informal learning that takes place at this SME is unstructured, impromptu, and reactive (Watkins & Marsick, 1992), which aligns with the fast-paced nature of the SME workplace and the need for employees to be flexible (Coetzer et al., 2017). Kankaras (2021) found that the type of workplace learning environment is largely influenced by the economic sector a company belongs to, and in this study, I found that the the dynamic nature of the coworking industry, in particular, places an even greater emphasis on the need for employees to be agile in their learning. Given the specific characteristics of the industry, employees must continually acquire new skills and knowledge to keep up with the demands of the field.

However, this reliance on informal learning can also lead to a tension between the benefits of increased autonomy and empowerment, and the potential for overburdening of employees (Lemmetty & Collin, 2020; Garrick, 1998). From this viewpoint, learning can be considered problematic if an employee is unable to keep track of their own learning or if the employer does not provide the necessary support, and tools for monitoring learning (Lemmetty & Collin, 2020). In accordance with the work of Lemmetty and Colling (2020), the results of my study indicate that learning should not be completely self-driven, and the SME operations should have structures in place to help employees to learn, apply knowledge and skills, and manage challenges.

Informal learning at Nomad was also portrayed positively as empowering. In this context, learning was seen as a possibility rather than a responsibility (Lemmetty & Colling, 2020). Consistent with previous studies on SMEs (Coetzer et al., 2019), the sense of empowerment among employees at Nomad is shaped by their relationships with the owner-manager (Grieves, 2003). The owner-manager often challenges employees to strive for more. Furthermore, the open environment of the cowering space encourages employees to be enterprising (Fournier, 1998), and to take initiative in seeking out new learning opportunities, which enhances their learning.

Furthermore, the unique nature of the coworking space at Nomad was emphasized as a location where employees collaborate on various projects, leading to learning opportunities. The collaborative learning activities found in this study align with the perspective of Kaendler et al. (2015), in which collaboration is seen as the sharing of knowledge to construct a shared understanding, while cooperation pertains to the individual tasks that are eventually brought together (Crans et al., 2021). The work environment of the employees in this study necessitates both cooperation and collaboration, and hence the collaborative learning activities may be an inherent part of the nature of their work (Crans et al., 2021).

The collaborative nature of the coworking space promotes the establishment of strong internal and external networks (Crans et al., 2021), which in turn promotes knowledge sharing, creativity, and idea generation (Bouncken et al., 2018). Employees describe the internal network as a family where there is mutual responsibility and loyalty. However, to effectively engage in social informal learning, employees needed to be aware of the relevant knowledge that their network can provide (Crans et al., 2021). In this study, employees tend to look to individuals with high status and power as sources of knowledge and expertise, which also affects how they approach self-directedness in their learning (Kim & McLean, 2014). They prefer to learn from more experienced colleagues or, ideally, the owner-manager. One possible explanation for this is that Kuwait has a high-power distance culture (Hofstede, Hofstede, & Minkov, 2010), where the owner-manager and senior members of staff can be seen as a fatherly figure (Kim & McLean, 2014).

Building relationships with internal colleagues was not the only valuable method of facilitating knowledge sharing. Participants also found external networks to be a unique source of information. They compared their local networks with international networks, which gave them a deeper understanding of the unique challenges and opportunities of working in Kuwaiti SMEs. This highlights how the cultural and societal context of Kuwait shapes the way informal learning is perceived and practiced within the SME coworking space. For example, the local culture places a strong emphasis on networking and collaboration (Hofstede et al., 2010), and this is reflected in the way participants described their informal learning practices as closely tied to building and maintaining relationships with both internal and external networks.

5. Conclusion

In conclusion, the present study has provided insight into the complexities of informal learning in the context of workplace learning within an SME coworking space provider in Kuwait. My findings suggest that informal learning in this context is highly unstructured, reactive and spontaneous (Marsick & Watkins, 1990), largely driven by internal and external networks, and shaped by the cultural and societal context. Additionally, my findings suggest that social informal learning is the most prominent way of learning in SMEs. These insights can help inform future research and assist in developing strategies for promoting informal learning within SME coworking spaces, as well as other SMEs. Further research is needed to explore the ways in which these contextual factors may impact the effectiveness of informal learning in the workplace.

6. Limitations

The limitations of this study must be considered. This study is based on a small sample and it does not seek to generalise its findings. Given the methods used, my research does not attend to the matter of causality (Conway & Briner, 2005). Furthermore, as I was in charge of the research from start to finish, this inevitably puts me in a position of control. As Archer (2002) argues problems with representation are involved throughout analysis and explanations of findings. Furthermore, the kind of information generated here is an outcome of the researcher selecting or, due to the constraints of this article, leaving out certain stories (Archer, 2002).

Conflict of interest: none.

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Enhancing Business Operations with TensorFlow and Neural Network-based Data Analysis

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Abstract: A simplified example of building a neural network using TensorFlow is presented in this article. A single-layer neural network, trained with a small dataset of seven data points and optimized with Stochastic Gradient Descent and a mean squared error loss function, is defined for predicting house prices based on the number of rooms. A prediction for a new value is then made with the trained model. This example serves as a demonstration of the potential for neural networks, in combination with TensorFlow, to bring about increased efficiency, productivity, and improved decision making in business and the economy through automation of tasks and processes. This article demonstrates how the use of neural networks can bring increased efficiency and productivity in business operations through the automation of data processing tasks. The implications and possibilities of using neural networks are also analyzed. This paper will serve as a resource for researchers and practitioners interested in using TensorFlow and neural networks for machine learning and data processing. By automating data analysis and prediction, businesses can make more informed decisions and respond more quickly to market changes, resulting in improved financial performance.

Keywords: neural network; prediction; machine learning; efficiency, productivity

JEL Classification: C45; C63

1. Introduction

Machine learning, a field that enables computers to learn from data and make predictions or take actions, has become a promising solution for various applications including data processing, pattern recognition, and decision-making. One of the essential components of machine learning is the use of algorithms, among which neural networks are gaining popularity. Inspired by the human brain's structure and function, neural networks are well-suited for complex pattern and relationship tasks (Howal et al., 2020). TensorFlow, an open-source machine learning framework, has emerged as a popular choice due to its ease of use and flexibility. This framework allows developers to build, train, and deploy machine learning models with a focus on neural networks. In this paper, an overview of TensorFlow and its capabilities is presented, with the examination of the use of neural network-based machine learning techniques for data processing.

Over the past decade, the growth of artificial intelligence (AI) has had a significant impact on the economy, particularly in the areas of management and business. AI technologies have enabled businesses to streamline their operations and improve efficiency, leading to increased productivity and profitability (Aghion et al., 2018; Wilson

et al., 2022). In addition, AI has also enabled businesses to better understand their customers and tailor their products and services to meet their needs. This has led to improved customer satisfaction and increased sales. However, there are concerns about the potential impact of AI on employment, as automation may lead to job losses in certain sectors. Overall, the growth of AI has had both positive and negative effects on economic growth, and it will be important for businesses and policymakers to continue to monitor and adapt to these changes (Aghion et al., 2018; Korinek & Stiglitz, 2021).

Artificial intelligence is being used to achieve sustainable economic growth and competitiveness. Improving the quality of services, saving time and money for citizens, and developing industries to world standards are key goals. Economic growth in most countries has slowed due to global imbalances, necessitating the need to find new sources of growth. AI has the potential to drive economic growth in the future (Qizi et al., 2021).

The process of using TensorFlow for machine learning, specifically building, training, and deploying neural networks, is then delved into. The various algorithms used in neural network-based machine learning techniques for data processing are also reviewed.

The aim of the paper is to provide an overview of possibilities for researchers and practitioners interested in TensorFlow and neural networks for machine learning and data processing and to inspire further exploration and innovation.

This paper introduces TensorFlow, a framework for building and training machine learning and deep learning algorithms. The focus is on neural networks, a type of artificial intelligence modeled after the structure and function of the human brain. Neural networks are made up of interconnected nodes, called artificial neurons, that process and transmit information. TensorFlow is an open-source library for numerical computation and machine learning, making it an ideal choice for building neural networks. It allows users to define the structure of a neural network, including the number of layers, neurons in each layer, and activation functions, and then train it using a large dataset (Heghedus et al., 2019; Howal et al., 2020). Neural networks have a wide range of applications, from predicting customer behavior and stock prices in business, to image recognition and speech recognition in daily life. This paper aims to provide an overview of TensorFlow and its capabilities for creating neural networks. It will examine the process of building, training, and deploying neural networks and discuss the various applications of neural networks in both business and daily life.

The process of training and tuning a neural network, using TensorFlow, involves selecting appropriate training data, defining a loss function, and selecting an optimizer. The performance of neural networks is also evaluated using metrics such as accuracy, precision, recall, and F1 score. The deployment of neural network-based models in production environments and the challenges and considerations involved are examined. The versatility and widespread use of TensorFlow as an open-source machine learning framework for prediction tasks across various industries, including healthcare, finance, and technology, are noted.

Here are a few real-world examples of how TensorFlow predictions are utilized (Leibowitz et al., 2017):

• Image Classification – TensorFlow trains models for image classification, allowing for real-time predictions in applications like self-driving cars or security cameras.

• Speech Recognition – TensorFlow trains models for speech recognition, enabling real-time transcription for voice-controlled personal assistants and speech-to-text services.

• Natural Language Processing – TensorFlow trains models for natural language processing, allowing for real-time sentiment analysis and machine translation.

• Time Series Forecasting – TensorFlow trains models for time series forecasting, facilitating predictions of future events like stock prices and weather patterns.

• Healthcare – TensorFlow trains models for medical predictions, enabling telemedicine and personalized medicine through diagnosis and risk prediction.

These examples showcase TensorFlow's versatility and the value it brings to various industries. With its ability to train models for a wide range of prediction tasks, TensorFlow is a valuable tool for organizations and researchers alike. In neural network-based prediction, the following key factors determine the performance of the model (Litzinger et al., 2019; Liu et al., 2017):

• Data quality: A high-quality and relevant dataset is essential for training a successful model. Effective data preprocessing and feature engineering can also greatly improve model performance.

• Architecture selection: The choice of appropriate architecture, such as the number of layers and their types, plays a crucial role in model performance.

• Hyperparameter optimization: Selecting the right hyperparameters, such as the learning rate, number of epochs, and batch size, can significantly impact model performance.

• Regularization techniques: Regularization methods, such as dropout or weight decay, help prevent overfitting and enhance the model's generalization performance.

• Training method: Adequate training with sufficient epochs, using early stopping to prevent overfitting, and selecting an appropriate loss function all contribute to the performance of the model.

• Evaluation metrics: Testing the model on a test set and using relevant evaluation metrics, such as accuracy, precision, recall, and F1 score, provides insight into the performance of the model.

2. Methodology

The methodology of this study utilized TensorFlow, a widely used open-source machine learning library. Neural networks were applied as the primary model development and evaluation method. PyCharm, a Python Integrated Development Environment, was employed for coding and debugging. The implementation of neural networks was supported by several libraries such as numpy for numerical computing, scikit-learn for machine learning algorithms, pandas for data manipulation and analysis. The pre-processing and cleaning of the data were done using pandas, while feature extraction and transformation were performed with numpy and scikit-learn. The model was trained and evaluated with TensorFlow.

3. Results

This code implements a simple machine learning model for predicting house prices based on the number of bedrooms. The model is built using TensorFlow and Numpy and is composed of a single dense layer with one unit. The model is trained using Stochastic Gradient Descent (SGD) optimizer and mean squared error as the loss function. The training data consists of two numpy arrays, xs and ys, representing the number of bedrooms and corresponding house prices, respectively. After training the model for 500 epochs, it can be used to make predictions for houses with any number of bedrooms.

This implementation could be improved by adding more layers to the model, using a different optimizer or loss function, training the model on more data or for more epochs, or using data normalization to scale the input values.

The core of neural network in TensorFlow for data prediction:

```
    import tensorflow as tf
    import numpy as np

    def house_model():

        model     =     tf.keras.Sequential([tf.keras.layers.Dense(units=1,
input_shape=[1])])
        model.compile(optimizer='sgd', loss='mean_squared_error')
        xs = np.array([1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0], dtype=float)
        ys  =  np.array([50.0,  100.0,  150.0,  200.0,  250.0,  300.0,  350.0],
dtype=float)
        model.fit(xs, ys, epochs=500)
        return model

    model = house_model()

    new_x = 14.0
    prediction = model.predict([new_x])[0]
    print(prediction)
```

The model then minimizes loss function and show prediction for new value:

```
    Epoch 497/500
    1/1 [==============================] - 0s 996us/step - loss: 0.4277
    Epoch 498/500
    1/1 [==============================] - 0s 997us/step - loss: 0.4244
    Epoch 499/500
    1/1 [==============================] - 0s 997us/step - loss: 0.4212
    Epoch 500/500
    1/1 [==============================] - 0s 997us/step - loss: 0.4179
    1/1 [==============================] - 0s 58ms/step

    [697.3694]
```

This code provides a basic illustration of constructing a neural network using TensorFlow. The required libraries are imported, and a function, house_model, is defined to establish a single-layer neural network architecture. The model is then compiled with the Stochastic Gradient Descent optimizer and the mean squared error loss function. The model is trained on a dataset of seven data points to predict a continuous variable. After training, the model is used to predict a new value, 14.0, which returns a prediction of 697.3694.

It is noteworthy that this code only serves as a rudimentary demonstration of building a neural network with TensorFlow. The model can be enhanced by adding additional hidden layers, incorporating more variables, and applying more advanced techniques. This example serves to provide a basic understanding of the fundamental components involved in building a neural network with TensorFlow and can act as a starting point for developing more intricate models.

This study showcases the capabilities of TensorFlow and neural network-based machine learning in data prediction. A simple feedforward neural network was trained to predict house prices based on the number of rooms, as described in the code. The model's accuracy was optimized by minimizing the mean squared error loss function.

The implications of using TensorFlow and neural networks in business and the economy are far-reaching. Companies can use these techniques to predict consumer behavior and demand, thereby streamlining their supply chains and improving their financial performance. Financial institutions can utilize these methods to identify fraudulent activities and manage risk, leading to reduced losses and increased stability (Muñoz-Ordóñez et al., 2018). Governments can also benefit from these techniques by analyzing and predicting economic trends, making data-driven decisions about economic policy.

In addition to these benefits, the use of TensorFlow and neural networks can also aid in automating various tasks and processes, freeing up time and resources for more valuable pursuits. This can result in increased efficiency and productivity, enabling organizations to stay competitive in a rapidly evolving business landscape (Sun et al., 2016). In conclusion, the application of TensorFlow and neural network-based machine learning in data prediction has the potential to transform the way organizations and governments approach data analysis and decision-making. By harnessing these powerful tools, businesses and economies can become more agile, efficient, and resilient, and better equipped to tackle the challenges and opportunities of the digital era.

4. Discussion

Python, a widely used high-level programming language, is commonly utilized in scientific computing, data analysis, and artificial intelligence. TensorFlow, an open-source machine learning and deep learning library developed by the Google, extends the capabilities of Python. Neural networks have proven to be valuable in various fields, including computer vision, natural language processing, speech recognition, and autonomous vehicles. These networks improve productivity and efficiency by automating tasks that would otherwise require human involvement (Morse & Stanley, 2016). In computer vision, neural networks classify and detect objects in images and videos, leading to increased efficiency in

applications such as security surveillance and medical imaging. In natural language processing, neural networks analyze and comprehend text data, facilitating the automation of tasks such as sentiment analysis and language translation.

Speech recognition systems have also improved through the use of neural networks for speech transcription and understanding. In autonomous vehicles, neural networks detect and classify objects, contributing to safer and more efficient operation.

In conclusion, neural networks have made a significant impact in boosting productivity and efficiency across various fields. As technology continues to advance, it is anticipated that the utilization of neural networks will expand to an increasing number of applications (Abadi et al., 2016). This code illustration showcases the ease of building a predictive neural network using TensorFlow. The single-layer feedforward neural network presented is designed to estimate the price of a house based on its number of rooms. The model's accuracy is optimized through the minimization of mean squared error loss function.

The integration of TensorFlow and neural network-based machine learning techniques has a substantial impact on businesses and economies. Companies can apply these techniques to anticipate consumer behavior and product demand, enhancing their supply chain management and boosting their profits. Financial institutions can utilize these techniques to curb fraud and mitigate risk, minimizing losses and fortifying their financial stability. Governments can utilize these techniques to scrutinize and predict economic trends, facilitating informed economic policy decisions. Additionally, the implementation of TensorFlow and neural networks can also simplify several tasks and processes, freeing up resources for more valuable endeavors. This results in elevated efficiency and productivity, helping organizations stay ahead in an ever-evolving and complex business environment. The automation of data processing tasks using neural networks and TensorFlow has the potential to significantly reduce labor costs, increase accuracy and speed of data analysis, and enable businesses to make data-driven decisions that lead to increased profitability (Aghion et al., 2018).

In summary, the integration of TensorFlow and neural network-based machine learning techniques into data prediction has the potential to transform the way organizations and governments analyze and make decisions based on data. These powerful tools equip businesses and economies with the ability to be more adaptive, efficient, and robust, and effectively tackle the challenges and opportunities of the digital era (Heghedus et al., 2019; Yuan et al., 2017). It's noteworthy that the code provided is a basic example and offers ample scope for improvement and customization. The model can be enhanced by adding multiple hidden layers, integrating additional variables, and adopting advanced techniques. This example serves as a foundation for more complex models and emphasizes the versatility and capability of TensorFlow for data prediction.

5. Conclusions

In conclusion, TensorFlow and neural network-based machine learning techniques have enormous potential for transforming data analysis and decision making. The code provided serves as a starting point for building feedforward neural networks for continuous data

prediction using TensorFlow. This simple example showcases TensorFlow's versatility and effectiveness, and highlights the opportunities for improvement and customization. The implementation of these techniques can bring significant benefits to various organizations and governments, such as improved accuracy and efficiency, reduced risk, and improved competitiveness. The application of TensorFlow and neural networks is expected to continue to drive innovation and progress in various fields in the future.

This paper can be used as a valuable resource for managers and executives who are interested in leveraging the power of machine learning to optimize their operations and stay competitive in the marketplace. As more companies adopt these technologies, it could lead to an overall increase in economic efficiency and competitiveness. This paper provides a glimpse into the possibilities of using machine learning to achieve better business outcomes and contribute to the overall growth of the economy.

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Measuring China's Digital Economy and Analyzing its Influencing Factors

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Abstract: In the information age, the digital economy will drive the transformation of the Chinese economy into high-quality development. In this paper, we define the digital economy in terms of input, output, and environment, measure China's digital economy by the entropy method and analyze its regional differences. Further, we analyze the spatial correlation between the provincial digital economies through the Moran index and then explore the factors that influence the development of the digital economy through the spatial Dubin model. We find that: First, China's digital economy is unbalanced in the provinces, with the level of development decreasing in three tiers based on the economic level of urban agglomerations. Specifically, the three economic centers of Beijing, Guangdong, and Shanghai are in the first tier, while the six provinces and cities of Jiangsu, Zhejiang, Shandong, Fujian, Sichuan, and Tianjin are in the second tier and the remaining provinces are in the third tier. Second, China's digital economy has spatial correlations across provinces, indicating that its development is not strictly constrained by regions. Third, further research shows that factors including economic development level, the intensity of government support, regional marketization, and industrial structure will propel the digital economy.

Keywords: digital economy; spatial Dubin model; new development pattern; regional marketization

JEL Classification: O11; C23; C52

1. Introduction

The sudden outbreak of COVID-19 has challenged traditional models of economic development. With its non-exclusive, non-contact, convenient, and innovation-driven characteristics, the digital economy has effectively reduced transaction costs and comprehensively reconstructed the social relations of economic activity. The total output of China's digital economy in 2020 surpassed 39.2 trillion yuan and accounted for 38.6 percent of the GDP (CAICT, 2020). To ensure the steady growth of the digital economy, the Fourteenth Five-Year Plan of China mentioned vigorously integrating the digital and the real economy, to speed up the establishment of a "dual circulation" development pattern.

Accurately defining the digital economy is the premise of this study. Sun and Wang (2004) believe a shift in production tools will inevitably change economic form. With the widespread use of modern production tools, the dominant industrial economy began to gradually shift to an information economy. Pang and Zhu (2013) also identify the digital economy as essentially using digital tools such as the Internet, mobile devices, and computers to digitize

communication and consumer transactions. Meanwhile, the G20 Summit held in 2016 defined it as a broad economic activity with digital information as the key production element and modern information networks as vital carriers (G20 Digital Economy Task Force, 2016). However, the rapid digitization of the economy and society also created many governance difficulties, so digital economic connotation should cover digital governance. So, at the measurement level, we add the necessary dimension of the digital governance environment, characterized by government digital governance and enterprise digital governance.

The marginal contribution of this paper is that, first, we define the digital economy in terms of input, output, and environment to provide the theoretical basis for the construction of a measurement system. Second, we use the entropy method to measure China's current digital economy and further discuss the causes of the imbalance in provincial digital economies. Third, we select a spatial econometric model for empirical analysis to verify the factors affecting the development of China’s digital economy and provide targeted policy recommendations.

2. The Connotation of the Digital Economy

The development pattern of the traditional economy has been transformed by the digital economy by innovating input factors, improving factor productivity, and optimizing the economic operating environment (Jing & Sun, 2019). Therefore, we define the connotation of the digital economy by exploring how it differs from the traditional economy in terms of inputs, outputs, and environment.

From an input perspective, data has become an essential factor of production in the digital economy (Yang, 2020). Unlike traditional elements such as land and capital, the production of data elements requires substantial investments in software and hardware and knowledge-intensive human capital at an early stage. Specifically, the explosive growth of data comes from the birth of networks such as the Internet and the Internet of Things, whose connectivity relies on various mobile and sensing terminals. Therefore, digital infrastructure investment is an indispensable "foundation" of the digital economy. Moreover, the process of transforming fragmented data into valuable data elements requires the involvement of sophisticated digital talent. As a result, the digital economy requires more highly skilled and innovative talents than the agricultural and industrial economies.

From an output perspective, changes in factor endowments spawned new industries and new formats, namely digital industrialization (Yang, 2020). Typically, the Internet-based software and information technology services industries emerged due to the rapid growth in demand for data analytics and software research and design. In addition, the deep integration of digital technologies with traditional industries is improving factor productivity, namely industrial digitalization (Wan et al., 2019). Specifically, agricultural digitalization applied IoT and intelligent detection technologies to improve production efficiency and expanded sales channels for agricultural products by building rural e-commerce. Industrial digitalization is reflected in the use of information technology by industrial enterprises to optimize their production processes. The digitalization of traditional service industries has improved the operational efficiency of the economy and society. For example, e-commerce solved the difficulty of finding and matching between trading parties, accelerating the flow of products.

Digital finance alleviates the borrowing difficulties of small companies and individuals (Laeven et al., 2015), thereby improving the productivity of the capital element as a whole.

From the environmental perspective, the utilization of digital technology improved the operational efficiency of governments and enterprises and thus optimized the economic operating environment. For the government, the integration of digital technology and public services, as represented by online government platforms, connects the government, enterprises, and people in a more efficient way. Meanwhile, digital construction such as "digital city" and government big data platforms will help the government to deeply understand the economic and social operation and achieve scientific and accurate social governance. For enterprises, the application of data mining techniques can help companies to identify potential demands that have been overlooked in the traditional economy, cultivate new market segments, and reduce supply distortions caused by information research and judgment errors, thus optimizing stock (Wu & Ren, 2022). In addition, big data technology can break down hierarchical barriers and accelerate information transmission within enterprises (Ren & Sun, 2022).

Table 1. Evaluation indicator system of the digital economy

Basic Dimensions	Secondary dimensions	Measurement indicators
Basic investment	Hardware facilities	Number of broadband access ports per square kilometer
		Number of broadband users per square kilometer
		Mileage of long-distance optical cable per square kilometer
		Number of mobile base stations per square kilometer
	Network resource	Number of IPv4 addresses
		Number of domain names
		Number of pages
	Intellectual input	Number of college students per 100,000 population
		The proportion of scientific research and technical service industry employees in total employment
		The proportion of information transmission, software and IT services employees in total employment
Digital industrialization	Telecommunication industry	The volume of telecommunication Services
		Mobile inter-access traffic
	Software and information technology industry	The scale of the software industry
		The scale of the IT service industry
	Electronic information manufacturing	Revenue of electronic information manufacturing industry
		Import and export volume of the electronic information manufacturing industry
Industrial digitalization	Agricultural digitalization	Length of rural delivery line per square kilometer
		Number of agrometeorological observation stations
	Industrial digitalization	Technical transformation cost of industrial enterprises
		The full-time equivalent of R&D staff in industrial enterprises
		Effective invention patents of industrial enterprises
	Electronic commerce	E-commerce sales
		The proportion of enterprises with e-commerce
	Digital finance	The digital inclusive financial index
Digital governance environment	Digital governance of government	Index of online government affairs capability
		Influence index of government microblog
	Digital governance of enterprise	Degree of digital transformation of listed companies

3. Methodology

3.1. Indicator System

From the above connotation, we establish an evaluation system from four basic dimensions: basic investment, digital industrialization, industrial digitization, and digital governance environment.

3.2. Entropy Method

Whether the weights of each dimension are scientifically reasonable determines the accuracy of the measurement. The entropy method is chosen to assign weights to each indicator, with the core idea that the smaller the entropy value of an indicator, the larger its dispersion and the larger its weight in the comprehensive evaluation; in turn, the weight is smaller. The formulas are as follows:

Step 1: Dimensionless processing of the original data. The original data is processed using maximum difference normalization so that the indicators can be compared horizontally. For the positive indicators, the transformation formula is as follows:

$$y_{ij} = \frac{x_{ij} - min\{x_j\}}{max\{x_j\} - min\{x_j\}} (i = 1,2,3 \ldots, m;\ j = i, 2,3 \ldots, n) \quad (1)$$

x_{ij} is the jth indicator in year i. $min\{x_j\}$ is the minimum in all years and $max\{x_j\}$ *is* the maximum.

Step 2: Computing the share of the jth indicator in all years.

$$p_{ij} = \frac{y_{ij}}{\sum_{i=1}^{m} y_{ij}} \quad (2)$$

Step 3: Computing the jth indicator's entropy e_j.

$$e_j = -\frac{1}{ln\, m} \sum_{i=1}^{m} p_{ij} \times ln\, p_{ij} \quad (3)$$

Step 4: Computing the information entropy redundancy d_j.

$$d_j = 1 - e_j \quad (4)$$

Step5: Computing the jth indicator's weight ω_j.

$$\omega_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \quad (5)$$

Step 6: Calculate the Digital Economy Development Index (*DEDI*) for each province. The value of the *DEDI* ranges from 0 to 1 and is positively correlated with the level of digital economy development.

$$DEDI_i = \sum_{j=1}^{n} \omega_j \times y_{ij} \quad (6)$$

3.3. Spatial Dubin Model

To explore the factors affecting China's digital economy, we carry out an empirical test by the spatial Dubin model. The specific structure is as follows.

$$DEDI_{it} = \rho wDEDI_{it} + \beta X_{it} + \delta wX_{it} + \varepsilon_{it} \quad (7)$$

Where: $DEDI_{it}$ is the digital economy development index of the *i*th province in year *t*. X_{it} is the set of explanatory variables, containing economic development level ($Pgdp_{it}$), the intensity of government support (Gov_{it}), the degree of regional marketization (Mar_{it}), and industrial structure (Ind_{it}). ρ is the spatial auto-regressive coefficient, which measures the mutual influence of digital economy among neighboring provinces. w is the economic distance spatial weight matrix, δ measures the impact of the explanatory variables in neighboring provinces on the *DEDI* of this province, ε_{it} is the random error.

3.4. Data Resource

Taking into account data availability and scientific accuracy, the data from 30 provinces in China from 2015 to 2019 are selected, excluding Tibet, Hong Kong, Macao, and Taiwan. The original data are obtained from Statistical Yearbooks of provinces, the China Stock Market & Accounting Research Database, the Institute of Digital Finance Peking University, the Public Opinion Data Center of People's Daily Online, the E-government Research Center of National Academy of Administration, Marketization Index of China's Provinces Database. In addition, due to differences in the magnitudes of the original data in the empirical test section, these data are processed logarithmically.

4. Results

4.1. Analysis of the Digital Economy Development Gap among Provinces

Based on the entropy method and the evaluation index system, we calculate the digital economy development index (DEDI) of 30 Chinese provinces from 2015 to 2019, shown in Figure 1. Further analysis shows that the Chinese average digital economy index increased year-on-year. Specifically, in 2019, it increased by 67.32% compared to 2015. This indicates that the implementation of "Internet Plus", "Digital China" and other relevant digital strategies since 2015 has achieved remarkable results, and the digital economy has achieved great development on the whole.

However, at the spatial level, the development of China's digital economy is uneven, and 30 provinces can be ranked in three tiers according to their *DEDI*, as illustrated in Table 2. The first tier contains Beijing, Guangdong, and Shanghai, all sitting in the core economic area. The three regions focused on cutting-edge digital technologies and digital industries and promoted the digital transformation of favored industries to form a strong integrated strength. Driven by the first tier, Jiangsu, Zhejiang, and Fujian in the Pan-Yangtze River Delta, as well as Shandong and Tianjin in Bohai Rim New Area and Sichuan in southwest China, also have a comparatively developed digital economy, thereby belong to the second tier. This tier takes full advantage of its industrial base and geographical position and focuses on

building its strengths. The remaining 21 provinces have a slight gap in the digital economy, with an average annual development index below 0.1, falling into the third tier. Although the overall level of development in this tier is relatively low, some regions have unique patterns of digital economy development that can serve as a reference for others.

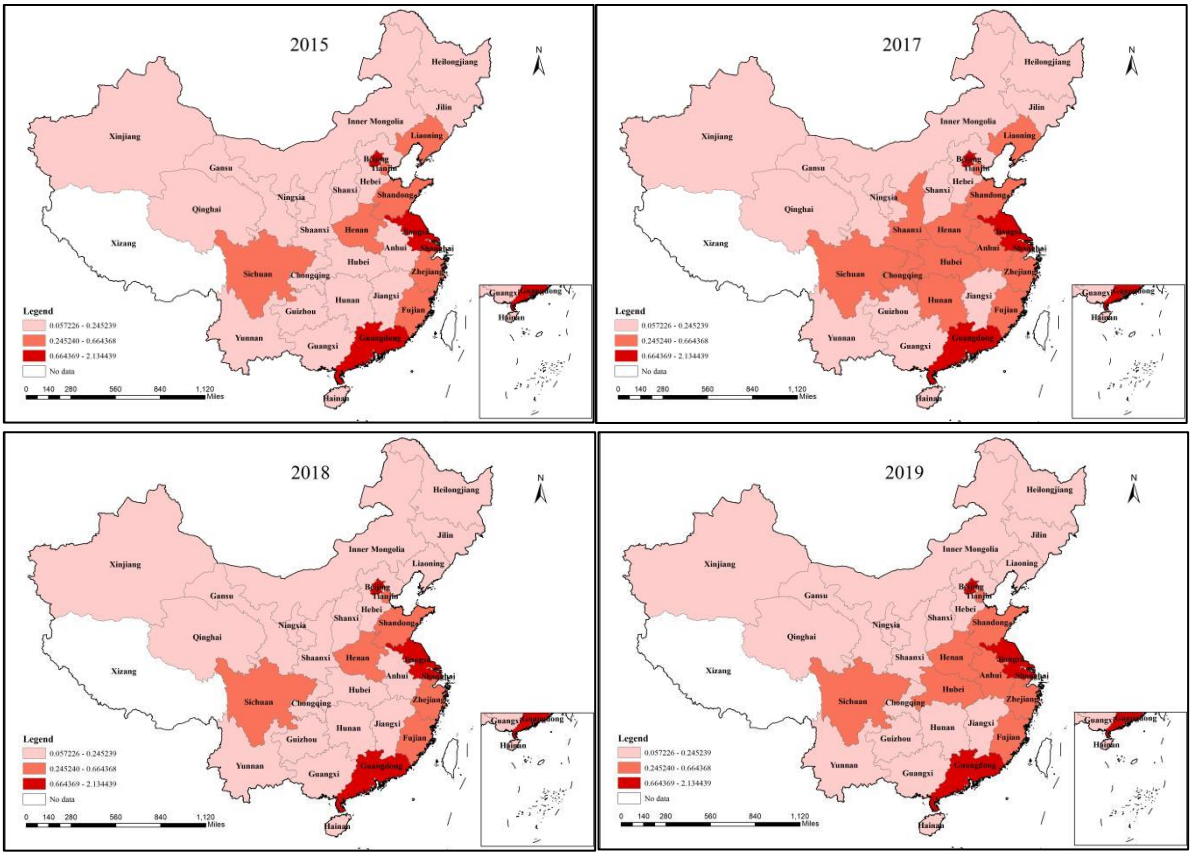

Figure 1. Spatial distribution of China's DEDI index for selected years

Table 2. Distribution tier of the digital economy in 30 Chinese provinces

The tier of the digital economy	Province and city
First Tier	Beijing, Guangdong, Shanghai
Second Tier	Jiangsu, Zhejiang, Shandong, Fujian, Sichuan, Tianjin
Third Tier	Henan, Hubei, Anhui, Liaoning, Shaanxi, Hunan, Chongqing, Hebei, Jiangxi, Guangxi, Shanxi, Hainan, Yunnan, Jilin, Guizhou, Heilongjiang, Gansu, Inner Mongolia, Xinjiang, Ningxia, Qinghai

Developing the digital economy has certain requirements on the self-development ability and industrial foundation of the region, which limits most of the less developed provinces and cities in China from developing their digital economy. We decompose the *DEDI* of each province according to the four basic dimensions to explore their strength of development.

Table 3 shows that the largest contribution dimension is a basic investment in 5 provinces, digital industrialization in 10 provinces, and industrial digitization in 15 provinces, while the digital governance environment is not the largest contribution dimension in any province. The possible explanation is that during the development process of the digital economy in recent years, most provinces and cities have focused on improving digital infrastructure,

Table 3. The largest contribution dimension of the digital economy in each province

The largest contribution dimension	Province	The index of the largest contribution dimension
Basic investment	Beijing	0.0301
	Shanghai	0.0177
	Tianjin	0.0057
	Hainan	0.0026
	Qinghai	0.0012
Digital industrialization	Guangdong	0.0368
	Jiangsu	0.0242
	Zhejiang	0.0108
	Shandong	0.0094
	Sichuan	0.0077
	Fujian	0.0060
	Henan	0.0048
	Shaanxi	0.0047
	Chongqing	0.0046
	Liaoning	0.0041
Industrial digitalization	Anhui	0.0052
	Hunan	0.0046
	Hubei	0.0044
	Hebei	0.0036
	Jiangxi	0.0027
	Guangxi	0.0026
	Shanxi	0.0024
	Yunnan	0.0024
	Guizhou	0.0022
	Jilin	0.0020
	Inner Mongolia	0.0020
	Heilongjiang	0.0018
	Gansu	0.0018
	Xinjiang	0.0017
	Ningxia	0.0013

building digital industries, and promoting the digital transformation of traditional industries. As a result, digital governance has not received sufficient attention and is still in the initial stages of building a government system that has yet to fully function. However, the digital governance environment will not only help improve the operational efficiency of the digital economy and optimize resource allocation but also help improve the convenience and happiness of people's lives. Since 2015, China has embarked on a major push to develop its digital economy. At present, the digital base in some provinces is relatively saturated and even partially redundant. Next, the establishment of a digital governance environment should be an important development direction.

For first- and second-tier provinces and cities, basic investment is the largest contribution dimension for Beijing and Shanghai, and digital industrialization is the largest for Guangdong, Jiangsu, Zhejiang, Shandong, Fujian, and Sichuan. These results show that the eight provinces with developed digital economies have focused on consolidating their digital foundations, and their rich digital manpower and large-scale digital industries have created strong and realistic competitiveness in their digital economies. For the third-tier provinces, Hainan and Qinghai have prioritized infrastructure construction despite their undeveloped digital economies, which will contribute to the introduction of emerging digital industries

and the integration of traditional industries and digital technology in the future. However, for the 15 provinces with industrial digitalization as the largest contribution dimension, over-emphasis on the digital transformation of traditional industries while neglecting basic investment and digital industrial development may leave their future digital economy facing problems such as lack of digital manpower and lack of competitiveness of digital industries.

To further explore the causes of the development gap between the three tiers, we subdivide the digital economy index of each province according to 12 secondary dimensions to compare the development differences in each tier. The result of the subdivision is shown in Figure 2.

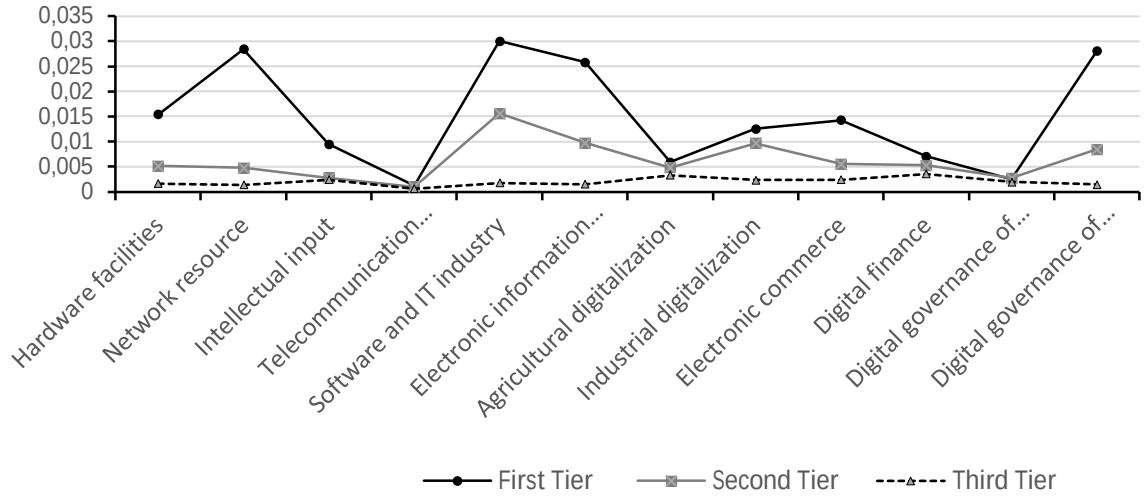

Figure 2. The digital economy development index for each tier based on secondary dimensions

The first tier is better developed than the second and third tiers in the following dimensions: hardware facilities, network resources, software and IT industry, electronic information manufacturing, and digital governance of the enterprise. The possible explanation is that Beijing, Guangdong, and Shanghai in the first tier are leading the country in terms of economic development level and richness of research resources, which provide solid financial support and technical support for the construction of their hardware and software infrastructure. In addition, their industrial development is oriented toward technological innovation, with a focus on cultivating or introducing highly innovative emerging digital industries. As a result, their digital industries have grown earlier and on a larger scale.

The gap between the second and third tiers exists in the dimensions of the software and IT industry, industrial digitalization, electronic information manufacturing, and digital governance of enterprises, while the remaining dimensions have relatively close development levels. The development of 12 dimensions within the second tier is also quite different, but the gap is not as sharp as in the first tier. Specifically, the development strengths of the second tier are the software and information technology industry, electronic information manufacturing, industrial digitalization, and digital governance of the enterprise. The development levels of the 12 dimensions within the third tier are relatively close, and all of them are at a low level, so there is a large room for development.

The above analysis shows that the development disadvantages of all three tiers are concentrated in the telecommunication industry, agricultural digitization, and digital governance of government. As a result, China's digital economy should focus more on these three shortcomings, vigorously develop digital agriculture and enhance the government's capacity for digital governance. In addition, differences in infrastructure investment have led to a serious "digital divide" between provinces. In economically developed provinces, advanced and well-developed digital infrastructure and abundant knowledge-intensive human resources enable the "network dividend" to be fully released, promoting the rapid expansion of digital industries. However, in economically undeveloped provinces, the lack of digital infrastructure has also prevented them from upgrading their industrial structure with new-generation information technology (Yan & Sun, 2012). In addition, the policies and regulations related to the digital economy in less developed provinces are relatively backward, hindering the construction of digital industrial bases and the introduction of digital enterprises (Yi et al., 2019).

4.2. Analysis of Provincial Spatial Correlation in China's Digital Economy

Spatial correlation is defined as the clustering of observed values of similar variables within a location. Wu (2006) believes that when the economic development of different regions is spatially dependent, location factors will affect the economic level, thus the estimator obtained by the ordinary least squares method is invalid. In this context, a spatial econometric model is needed to explore the factors influencing economic development. The Moran Index was chosen to test whether the provincial digital economy in China is spatially correlated. As is shown in Table 4, the significant positive value of the Moran Index indicates that the development of China's digital economy is spatially correlated, and it also suggests that developing the digital economy itself is not strictly constrained by geographical location.

Table 4. Moran index of China's digital economy from 2015 to 2019

Year	Moran Index	Z-value	P-value
2015	0.319	3.302	0.001
2016	0.319	3.295	0.001
2017	0.318	3.278	0.001
2018	0.292	3.043	0.002
2019	0.286	2.984	0.003

4.3. Analysis of Factors Influencing China's Digital Economy

The fitting results of the SDM model are reported in Table 5, where the coefficients ρ and δ are significant, suggesting again that China's digital economy is spatially correlated. Additionally, the variance inflation factor (VIF) can be used to check serious multicollinearity, with a VIF greater than 10 indicating severe multilinearity among explanatory variables. As shown in Table 5, the VIF of all explanatory variables is smaller than 10, so there is no serious multicollinearity. From the significant results of the explanatory variables, the economic development level, the degree of government support, the degree of regional marketization, and the industrial structure will effectively boost the digital economy.

Table 5. Regression results of an econometric model

Variables	SDM	OLS	VIF
Pgdp	0.9631*** (0.1350)	0.5644*** (0.0893)	3.50
Gov	0.2913*** (0. 0261)	0.3179*** (0. 0359)	3.37
Mar	0.8765*** (0. 1315)	0.9553*** (0.1666)	3.18
Ind	1.2077*** (0. 2873)	1.7202*** (0.3344)	1.66
ρ	-0.7479*** (0. 0882)		
δ	0. 0333*** (0. 0040)		
cons		-3.1331*** (0. 2809)	
N	150	150	

Note: * represents P-value <0.1, ** represents P-value<0.05, *** represents P-value<0.01; N is the sample size; numbers in parentheses are standard deviations.

The regional economic level will promote the digital economy from infrastructure, industrial base, innovation factors, and industrial introduction. First, economically developed regions tend to pursue high-quality economic development. While promoting rapid economic growth, they are also focusing on building digital infrastructures, like 4G base stations, fiber optic cables, and even 5G base stations, which are substructures for developing a digital economy. Second, the industrial layout in economically developed regions is relatively perfect, including basic digital industries such as electronic manufacturing and the IT industry, which has laid a solid hardware and software foundation for digital transformation (Liu et al., 2020). Finally, economically developed regions gather abundant educational and scientific research resources and thus are rich in talent, technology, and other elements of digital innovation, which is conducive to major technological breakthroughs and high-tech industry development.

The breakthroughs and transformations of major scientific and technological achievements will motivate the rapid growth of the digital economy. For example, breakthroughs in digital technologies like 5G and block-chains have made economic societies smarter. However, as a public good with a positive externality, basic research has a clear social spillover effect, which makes it difficult to achieve an efficient supply of basic research only through supply and demand adjustment by market mechanisms. Therefore, the intensity of government support in basic research will markedly affect the digital economy. The government should take the lead in connecting universities, research institutes, and enterprises, and provide the necessary financial support to jointly promote basic research in the new generation of digital technologies.

The degree of regional marketization is judged based on its product market, factor market, and legal environment in a comprehensive way (Wang et al., 2021). The higher the degree of marketization, the more mature the market mechanism and the perfect legal environment. On the one hand, in a highly market-oriented environment, the flow of input factors and the transmission of information is smoother. As a result, microeconomic entities

such as businesses respond more quickly to fresh market information than they would in a less market-oriented environment. On the other hand, microeconomic entities, mostly dependent on government directives and policies for their development in a low-marketization environment, are on a path of investment-driven development (Wang & Huang, 2021). However, microeconomic entities in highly market-oriented environments face a higher competitive environment and their development is more driven by innovation.

The development experience of developed countries shows that during the transition to industrialization, the industrial structure will gradually shift from labor-intensive to capital-intensive and finally to technology-intensive (Tang & Feng, 2019). According to the National Economic Industry Classification Standard, the modern service sector, represented by IT services, belongs to the technology-intensive sector. Thus, the deepening industrialization will upgrade China's industrial structure and ultimately boost its digital economy. Additionally, optimizing the industrial structure means that the proportion of tertiary sectors in the three sectors will increase. Modern services and modern commerce below the tertiary sector, represented by e-commerce, have a distinctly digital character. Therefore, upgrading the industrial structure of the region will boost the digital economy by expanding these modern digital industries.

5. Conclusions

Here are the main conclusions of the study: First, China's digital economy is spatially uneven, with 30 provinces showing a three-tier decline in the digital economic level. Specifically, the first tier performed significantly better than the second and third tiers in terms of the development of hardware facilities, network resources, software and IT industry, electronic information manufacturing, and digital governance of the enterprise. The development shortcomings of the three tiers are concentrated in the dimensions of the telecommunication industry, agricultural digitization, and digital governance of government. Second, China's digital economy has significant spatial correlations, so its development is not strictly limited by geographical location. Third, the level of regional economic development, government support, regional marketization, and industrial structure will positively affect the development of the digital economy.

As a result, we propose that China could implement a differential digital economy strategy for different tiers and industries. The first tier could actively establish a system of industrial-university research cooperation to promote basic research and focus on high-end and cutting-edge fields. The second tier could pay attention to the development linkages with the first tier, and actively integrate into the regional development strategic action. The third tier, as a whole, could focus on strengthening its digital infrastructure. Meanwhile, Chongqing, Hubei, and Anhui provinces could choose a targeted digital strategy based on their strong manufacturing bases. With rich natural and cultural resources, Tibet and Xinjiang could actively implement digital culture innovation and digital tourism.

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Unemployment as a Determinant of Credit Risk

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Abstract: This paper is based on the premise that credit risk has a significant impact on banking activity and is influenced by a number of determinants. The paper discusses possible determinants of credit risk with a focus on unemployment. The aim of the paper is to assess the long-term relationship between credit risk and unemployment. In this study, relationship between credit risk and unemployment was analyzed in a bank-based economy, represented by the Czech Republic, for the 2002-2022 period. Credit risk was represented by non-performing loans to household and non-financial corporations. The relationship is examined using the Engle-Granger cointegration test on monthly data. Based on the analysis, the increase in the unemployment rate was found to have an increasing impact on non-performing loans to households and non-financial corporations. Cointegration among the given variables was confirmed.

Keywords: banking; credit risk; non-performing loans; macroeconomic determinant; unemployment; cointegration

JEL Classification: G21; J64; C22

1. Introduction

Banks play a crucial role on financial markets as financial intermediaries, which ensure the flow of free financial resources between individual economic entities. In particular, by providing loans, they influence consumption and investment, which can support the economy. The banking sector is therefore an important component of economic development, especially in countries whose financial systems are classified as bank-based and where banks have a significant position, as is the case in the Czech Republic. Like other businesses, banks generate profits. A stable, profitable and efficient banking system is necessary to finance both private and public investments and expenses, especially in times of economic fluctuations.

By the core of their activities, banks are exposed to a range of financial risks. The materialization of any financial risks can affect bank profitability. The disruption of the stability of the banking sector can lead to a stagnation of the transfer of free financial resources from surplus units to deficit units, which can result in a slowdown in economic development. For this reason, it is necessary to pay attention to factors that can affect the stability of the banking sector. Since credit activities are one of the main activities of the banking sector, the most significant risk is credit risk. Credit risk represents the risk of financial losses for banks in cases where their counterparties do not meet their obligations on

time due to inability to pay. The materialization of credit risk can be the beginning of a banking system crisis (Castro, 2013; Reinhart & Rogoff, 2010).

The issue of increasing credit risk is currently relevant, especially in connection with the ongoing consequences of the Covid-19 pandemic and further in connection with geopolitical changes in the world. In the context of changing market conditions, it is possible that a number of entities will not be able to meet their previous commitments due to the restriction of economic activity and the related restriction of business operations and layoffs of employees. Unemployment has consequences not only for individuals, but also for society and its economy, where one of the potential areas affected is credit risk. Therefore, the aim of the paper is to assess the existence of a relationship between credit risk and unemployment. The paper will discuss possible determinants of credit risk with a focus on unemployment, assess the long-term relationship between credit risk and unemployment, and based on the results, formulate recommendations to eliminate the impact of unemployment on credit risk.

One way to quantify credit risk is through non-performing loans (Ahmad & Ariff, 2007; Castro, 2013; Foglia, 2022; Chaibi & Ftiti, 2015; Khan et al., 2018; Naili & Lahrichi, 2022; Nikolopoulos & Tsalas, 2017). The rate of non-performing loans can affect the profitability of banks.

There are a number of determinants of credit risk. These can influence credit risk both positively and negatively. Generally, these factors can be divided into two categories (Ahmad & Ariff, 2007; Anastasiou & Louri, 2016; Chaibi & Ftiti, 2015; Khan et al., 2018; Louzis et al., 2012; Messai & Jouini, 2013; Naili & Lahrichi, 2022; Nikolopoulos & Tsalas, 2017; Salas & Saurina, 2002; Swamy, 2012).

The first category is internal factors. These are factors specific to the bank. These are internal factors that may arise from the decisions of the bank's management and their political goals. The relationship between bank-specific characteristics and non-performing loans and efficiency indicators was first studied by Berger and DeYoung (1997). Using four hypotheses, namely "bad luck", "bad management", "skimping" and "moral hazard", they formulate possible mechanisms for the relationship between internal factors and loan performance. By examining a sample of US banks from 1985 to 1994, it was concluded that cost efficiency may be an indicator of the future development of problematic loans. Podpiera and Weill (2008) built on this work. They extended the model to include the generalized method of moments (GMM), which they applied to a sample of Czech banks from 1994 to 2005. Their results also confirm that an increase in non-performing loans precedes a deterioration in cost efficiency.

The analysis of bank-specific factors has also been studied by Ahmad and Ariff (2007). They present a comparative study of factors affecting credit risk in the period 1996-2002 in developed and developing economies. They consider the efficiency of management, loan losses, the loan-to-deposit ratio, leverage, regulatory capital, financing costs, liquidity, spreads, and total assets to be determinants of credit risk specific to the bank. They find that for banks with a dominance of lending in developing economies, the quality of management is crucial, while for banks offering a range of products, regulatory capital is essential. The

influence of two to four factors significantly determines credit risk in both developing and developed economies.

The second category is external factors. These are external factors that reflect the business environment in which the bank is operating. This category includes macroeconomic factors, which are beyond the control of the bank's management. These factors can also affect the credit risk and profitability of the bank. This category includes GDP, inflation, interest rates and unemployment (Berge & Boye, 2007; Castro, 2013; Chaibi & Ftiti, 2015; Khan et al., 2018; Naili & Lahrichi, 2022; Nkusu, 2011; Petrovski et al., 2018; Rinaldi & Sanchis-Arellano, 2006; Škarica, 2014). In addition, we can include in this category domestic credit, which has a positive impact on non-performing loas reflecting lower credit quality during increase in credit, and public debt with a negative effect due to the sample selected in the study (Foglia, 2022). Khan et al. (2018) also included tax rate, whereby their results indicate positive relation between the tax rate and non-performing loans ratio with lesser ability of the borrowers to repay their loans at higher level of tax rate. A rising GDP implies an economic recovery. With rising incomes, the financial situation of debtors improves, as does their payment ability. The trend of non-performing loans is therefore decreasing. On the other hand, in a recession, GDP decreases. A declining payment ability of debtors is accompanied by an increasing trend in the development of non-performing loans (Beck et al., 2015; Foglia, 2022; Chaibi & Ftiti, 2015; Petrovski et al., 2018). With increasing inflation, the real value of unpaid loans decreases and the real incomes are also devalued. If there is no increase in real incomes, the economic entities' costs will rise and their available financial resources for loan repayment will decrease, which will increase non-performing loans (Nkusu, 2011; Škarica, 2014). Interest rates have a direct impact on non-performing loans, with a positive relationship expected. As interest rates increase, the debt burden of subjects increases, leading to an increasing trend in non-performing loans (Berge & Boye, 2007; Castro, 2013; Chaibi & Ftiti, 2015; Nkusu, 2011; Rinaldi & Sanchis-Arellano, 2006). An increase in the unemployment rate reduces the consumers' ability to repay. Therefore, they will not be able to meet their loan repayment obligations, which will result in an increase in non-performing loans. Similarly, an increase in unemployment weakens the position of companies due to a decrease in demand for products and services, which affects their financial situation and ability to repay their debts. The relationship between unemployment and non-performing loans is therefore expected to be positive (Berge & Boye, 2007; Castro, 2013; Foglia, 2022; Chaibi & Ftiti, 2015; Khan et al., 2018; Nkusu, 2011; Rinaldi & Sanchis-Arellano, 2006).

The aim of this paper is to assess the impact of the unemployment rate on credit risk in the Czech Republic over the past 20 years, from 2002 to 2022.

Unemployment in the Czech Republic has fluctuated from 2002 to 2022 depending on economic conditions and other non-economic factors. Initially, there was a decreasing trend in unemployment in connection with economic growth and increasing demand for workers from companies. However, the financial crisis led to an increase in unemployment due to the deteriorating economic situation worldwide and a decrease in demand for workers. Subsequently, unemployment gradually decreased again as the Czech economy recovered. The Covid-19 pandemic also affected the development of unemployment, causing further growth due to the limitation of economic activity and layoffs of workers.

2. Methodology

The data in the article are from the Czech National Bank's ARAD Time Series System (Czech National Bank, 2022). The data are monthly for the time period of January 2002 to October 2022. For the analysis is credit risk represented by non-performing loans (NPLs) as it was in many reviewed studies (Ahmad & Ariff, 2007; Castro, 2013; Chaibi & Ftiti, 2015; Nikolopoulos & Tsalas, 2017). We selected non-performing loans to households (*NPL_hh*) and non-performing loans to non-financial corporations (*NPL_nc*). Both time series are expressed in relative terms as the ratio of NPLs to total loans. Unemployment (*unemploy*) is expressed as the gross unemployment rate in percentages. A total of 250 observations from the Czech Republic are used for the analysis. All of the time series are log-transformed, which leads to their stabilization.

An econometric analysis is conducted to establish the relationship between unemployment and non-performing loans. The method used is the Engle-Granger cointegration test for time series analysis. This method is used to determine the long-term cointegration between non-performing loans and one of its macroeconomic determinants, i.e. selected types of non-performing loans (*NPL_hh* and *NPL_nc*) and the unemployment rate (*unemploy*). The relationships of economic time series and their interdependence are examined using vector autoregressive models, which are used for testing cointegration and forecasting (Hušek, 2007). The use of this method is appropriate because it prevents spurious regression, which can be caused by common long-term trends in economic time series.

First, it is necessary to select an appropriate model and an optimal length of delay. This is done based on an information criterion that compares the residuals of models with different lengths of delay (Artl & Artlová, 2007). The Akaike information criterion is used. The Akaike information criterion can be expressed by the formula (Akaike, 1981):

$$AIC = n \cdot ln\,(\,RSS/n\,) + 2k \tag{1}$$

where *RSS* is the residual sum of squares, *RSS/n* is the residual variance, *k* is the number of parameters, and *n* is the number of measurements.

The next step is testing the stationarity of the variables. Stationarity of the variables is a prerequisite for using the vector autoregressive model, as non-stationary economic time series may exhibit common long-term trends that can lead to spurious regression (Hušek, 2009). A time series is stationary if the characteristics of its random variables do not change over time (Artl & Artlová, 2007). The conditions for stationarity can be written as follows: (Artl & Artlová, 2007):

The mean value function:

$$\mu t = E(Xt\,) \tag{2}$$

The variance function:

$$\sigma_t = D(X_t\,) = E(X_t - \mu_t\,)^2 \tag{3}$$

The covariance function:

$$(t,t-k) = E(X_t - \mu_t\,)(X_{t-k} - \mu_{t-k}\,) \tag{4}$$

The correlation function:

$$\rho(t,t-k) = \gamma(t,t-k)/\mu_t\sigma_{t-k} \quad (5)$$

where X_t is the dependent variable, $E(X_t)$ is the mean, and $D(X_t)$ is the variance.

Stationarity is verified by the unit root test. In the presence of a unit root in the VAR model, it is non-stationary. Using the Augmented Dickey-Fuller test (ADF test), the presence of a unit root is examined. The hypotheses are formulated as follows (Dickey & Fuller, 1979):

- H_0: a unit root is present in the time series,
- H_1: a unit root is not present in the time series.

The resulting p-value of the given analysis is compared with the significance level α, which is set at 0.05. If the p-value is greater than α, H_0 is not rejected. Then a unit root is present in the time series, and the time series is non-stationary. In such a case, by converting to first or second difference, the stationarity of the time series is achieved (Hušek, 2009).

In the next step, the time series' cointegration is tested. Variables are considered cointegrated if they report interdependence. Variables are considered long-run dependent if they do not diverge in the long run and if their economic relationship can be explained (Artl & Artlová, 2007). The system may under certain limits, due to shocks, show some deviations from the direction in which it is moving, but then it will return to the long-term dominant level.

Cointegration is tested using the Engle-Granger cointegration test. The Engle-Granger test works on the basis of a unit root test and the estimation of cointegration regression residuals. The EG test works with stationary variables. The hypotheses are formulated as follows (Engle & Granger, 1987):

- H_0: the time series are not cointegrated,
- H_1: the time series are cointegrated.

The resulting p-value of the given analysis is compared with the significance level α, which is set at 0.05. If the p-value is higher than α, we do not reject H_0, the time series are not cointegrated, and there is no long-term dependence. When testing cointegration, the following formula is assumed (Artl & Artlová, 2007):

$$\Delta X_t = (\emptyset_1 - 1)X_{t-1} + \sum ai\Delta X_{t-1} + e_t \quad (6)$$

where X_t is the dependent variable, e_t is the residual, and p is the lag.

3. Results

The subject of analysis is to test the relationship between non-performing loans of households and non-performing loans of non-financial corporations and the unemployment rate in the Czech Republic using monthly data from January 2002 to October 2022. All of the time series are log-transformed, which leads to their stabilization. The level of significance α is set at 0.05. The calculations are carried out in the Gretl software. As part of the analysis, tests for optimal lag lengths, stationarity tests and verification of cointegration of time series, and possibly Granger causality tests will be performed.

The first step of the analysis is to determine the optimal lag length of the VAR model variables. This is done based on the results of the Akaike Information Criterion (AIC). The maximum lag length considered is 12 months. The optimal lag length is chosen according to the minimized AIC value. The test type with a constant or with a constant and trend is chosen. The resulting optimal lag orders and test type are used in the following analysis steps. The optimal lag length results and the chosen test types are presented in the Table 1.

Table 1. Optimal lag length results

Time Series	min AIC	Lag Lengths	Test
NPL_hh and unemploy	-4.002429*	7	with a constant
NPL_nc and unemploy	-4.115005*	9	with a constant

The next step is to verify the stationarity of the time series through the extended Dickey-Fuller test (ADF test). The null hypothesis H0: a unit root is present in the time series is tested. In the presence of a unit root in the VAR model, it is non-stationary. Based on the previous results, the test with a constant is selected. Stationarity is a prerequisite for further analysis, so non-stationary time series are made stationary by converting to differences. The logarithmic time series used as input (labeled l_ before the variable) were non-stationarity. Stationarity was achieved by converting to the first difference (labeled by d_ before the variable). Results are presented in the Table 2.

Table 2. ADF stacionarity test results

Variables	p-value	H_0	Stacionarity
l_NPL_hh	0.9250	not rejected	non-stationary
d_l_NPL_hh	0.0005122	rejected	stationary
l_NPL_nc	0.1991	not rejected	non-stationary
d_l_NPL_nc	0.01284	rejected	stationary
l_unemploy	0.8734	not rejected	non-stationary
d_l_unemploy	0.0000001847	rejected	stationary

The interdependence of pairs of time series is tested by Engle-Granger cointegration test. If their residuals are non-stationary, the time series are not cointegrated. The following table shows the results of the EG cointegration test for the pairs of time series *NPL_hh* and *unemploy*, and *NPL_nc* and *unemploy*. We consider the unemployment rate (*unemploy*) as the independent variable and non-performing loans (*NPL_hh* and *NPL_nc*) as the dependent variables. The results are in the Table 3. The optimal lag length and test type setting from the previous results are shown. The null hypothesis H_0: the time series are not cointegrated at the significance level α (0.05) is tested.

Table 3. Engle-Granger Cointegration Test Results

Time Series	Lag	Test	p-value	H_0	Relationship
NPL_hh and *unemploy*	7	with a constant	6.29×10^{-78}	rejected	*cointegration*
NPL_nc and *unemploy*	9	with a constant	5.99×10^{-46}	rejected	*cointegration*

Based on the Engle-Granger cointegration tests, long-run relationships were discovered between the non-performing loans to household and non-performing loans to non-financial

corporations and unemployment rate. Calculated p-values were below the α significance level set at 0.05; therefore, the null hypotheses on the time series' non-integration were rejected.

4. Discussion

Banks are exposed to a range of financial risks due to the nature of their activities. Given the centrality of lending activity in the banking sector, credit risk is one of the most significant of these risks. Credit risk was quantified through non-performing loans, as in Ahmad and Ariff (2007), Castro (2013), Chaibi and Ftiti (2015), and Nikolopoulos and Tsalas (2017).

Credit risk has a number of determinants. These can be divided into internal and external factors (Ahmad & Ariff, 2007; Anastasiou & Louri, 2016; Chaibi & Ftiti, 2015; Louzis et al., 2012; Messai & Jouini, 2013; Nikolopoulos & Tsalas, 2017; Salas & Saurina, 2002; Swamy, 2012). External factors include macroeconomic factors, such as unemployment. Unemployment affects individuals as well as society and the economy as a whole. In the context of the ongoing impacts of the Covid-19 pandemic, which has led to reduced economic activity and business closures and layoffs, and current geopolitical changes, unemployment is a factor that can cause the materialization of credit risk.

The aim of this article was to assess the impact of unemployment on credit risk in the Czech Republic over the past 20 years, from 2002 to 2022. The variables were represented by non-performing loans of households, non-performing loans of non-financial corporations, and the unemployment rate.

The results of our econometric analysis suggest that there is a long-term dependence between the development of household non-performing loans and the unemployment rate, and the development of non-performing loans of non-financial corporations and the unemployment rate. This was confirmed by the Engle-Granger cointegration test. Our results are consistent with the studies of other authors (Berge & Boye, 2007; Castro, 2013; Chaibi & Ftiti, 2015; Nkusu, 2011; Rinaldi & Sanchis-Arellano, 2006).

This confirmed the expectation that unemployment affects the performance of the loan portfolio. Unemployment can reduce the ability of an economic entity to repay its loans, leading to an increase in non-performing loans. Unemployment also weakens the position of non-financial corporations, as aggregate demand for goods and services declines, worsening their financial situation and ability to meet their obligations. The impact of unemployment on the credit portfolio may depend on various factors, such as the length of unemployment benefits in a given country.

Banks could eliminate the negative impact of unemployment by adapting loan conditions for entities in financial distress, such as allowing for the postponement of payments, reducing payments, increasing the number of payments, or allowing for a longer repayment period. Diversifying the credit portfolio with a focus on providing loans to applicants from different sectors and different geographic areas may also reduce the impact of unemployment in a particular sector or geographic area. Banks should also be cautious in providing loans to applicants from sectors that are more susceptible to unemployment. Our calculations show that governments, in implementing fiscal policy

and central banks, in implementing monetary policy, must consider unemployment as a significant determinant of credit risk in financial markets. The government's active employment policy can therefore influence the profitability and stability of the banking market and, in turn, financial intermediation.

Further research can focus on other macroeconomic factors that may somehow affect credit risk, or research can be expanded to a sample of more countries.

5. Conclusions

This article discusses the possible determinants of credit risk, focusing on the impact of unemployment. The aim of the article is to assess the existence of a relationship between credit risk and unemployment. Based on an econometric analysis using the Engle-Granger cointegration test, a long-term relationship between the unemployment rate and the rate of non-performing loans of households and non-financial corporations, which represent credit risk, was confirmed in the Czech Republic in the years 2002 to 2022. Financial market participants must consider unemployment as a significant determinant of credit risk. Banks can eliminate the negative impact of the unemployment rate on the quality of the credit portfolio by adjusting credit conditions to their clients, while the government can contribute through active employment policy. Unemployment is not the only determinant of credit risk, so future research must also focus on other factors. Extending the analysis to more countries is appropriate.

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doi: 10.36689/uhk/hed/2023-01-027 HED Hradec Economic Days

Applied Ethics for Future Managers

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Abstract: Teaching ethics to future managers is increasingly desirable. The ethical aspects of professions fundamentally affect people's lives. Currently, ethics is commonly considered in various fields of human activities, mainly due to the fact that the unprecedented development of new technologies posing new challenges, e.g., artificial intelligence (AI), or medical devices. Future managers should be taught business ethics as the new technologies are produced by companies and multistakeholder collaboration, a trend in current applied ethics, necessarily includes managers of companies producing these technologies. In this study, we ask the following questions: What are the shortcomings of our approach to teaching applied ethics? What should we change in the future to prepare our students well for their managerial work? In future, we shall focus much more on the corporate perspective of business ethics and continue in our practice of discussing examples of ethical problem solving that include conflicts between various ethical principles. The overall aim is to awaken and deepen future managers' ethical awareness.

Keywords: professional ethics; code of ethics; education

JEL Classification: M14; M10

1. Introduction

Since the 1990s, ethics and professional ethics have become increasingly important in the Czech Republic as a result of significant social changes. Direct evidence of this is the emergence of professional codes of ethics and the exploration of the ethical aspects of professions that fundamentally affect people's lives. Theoretical and practical outcomes can be found particularly in the fields of medicine, pharmacy, business and education. Codes of ethics are developed and refined in the light of social and technological developments and, over time, ethics committees are established to analyse and evaluate the suggestions of users of the results and services of individual professions in specific workplaces in relation to specific people and activities.

The gradual cultivation of not only the business environment also requires an increase in the importance of responsibility and competence in all job positions. It can be stated that the degree of responsibility and competence is linked to the place in the corporate, institutional and organisational hierarchy.

Currently, ethics is commonly considered in various fields of human activities. It is mainly due to the fact that the unprecedented development of new technologies poses new challenges and creates previously unthinkable issues. The application and utilisation of new technologies is particularly palpable in medicine. The use of medical devices, including

personal health monitoring technologies, poses ethical problems like patients' privacy, social isolation, or autonomy (see Mittelstadst, 2014). Other authors (e.g., Ikonen & Kaasinen, 2008) also name privacy, autonomy as ethical issues when discussing ambient-assisted living applied in health care. In the same vein, Sharkey and Sharkey (2012) see similar problem areas (loss of privacy, loss of personal liberty) in the use of robots in elderly care.

There is also a widespread discussion on the ethics of artificial intelligence. For instance, Solomonides et al. (2022) proposes machine ethics, seeking to apply ethical considerations into the design of AI (i.e., artificial intelligence) systems. Javed et al. (2022), who analysed 166 syllabi of various AI ethics courses, maintain that it has long been known that ethics should be taught to both tech professionals and AI practitioners in order to raise their ethical awareness and develop their skills for implementing ethical guidelines. Authors like Shih et al. (2021), Solomonides et al. (2022), Stenseke (2022), Hu et al. (2022), Leimanis and Palkova (2021) agree that multistakeholder collaboration is inevitable as it helps widen and enrich differing and partial views of individual stakeholders.

That said, future managers should also be taught applied ethics. First, all the above-mentioned technologies, be it medical devices, ambient-assisted living, robots, or artificial intelligence, are produced by various companies, not by healthcare workers. Second, the aforementioned multistakeholder collaboration necessarily includes managers of companies producing the technologies.

In a previous study (Kacetl & Semrádová, 2019), we claimed they favoured problem-based and reflective approach to teaching professional ethics. In the same vein, Hummel et al. (2018) argue that students should be encouraged to practise solving ethical problems themselves rather than learning ready-made expert solutions.

In the present study, we seek to determine the extent to which we are succeeding in preparing students for the future need to address ethical issues in their companies in light of current knowledge and approaches to applied ethics. The fundamental research questions we ask are: 1) What are the shortcomings of our approach to teaching applied ethics? 2) What should we change in the future to prepare our students well for their managerial work?

2. Methodology

At the Faculty of Informatics and Management (FIM), University of Hradec Králové (UHK), students of managerial study programmes can frequent a course of Business Ethics. The syllabus of Business Ethics (BE) covers several key areas, including basic concepts (ethics, morality, values, norms, codes of conduct), professional ethics (in particular ethics in medicine and ethics in education), business ethics and its history, main topics and problems, ethical decision-making in business, business ethics and its development in the Czech Republic since the 1990s, the creation and contents of codes of conduct, ethics relevant in human resources, common issues like discrimination, sacking, ethics of business communication, advertising and marketing ethics, corporate responsibility, and fair trade.

Teaching takes place over the course of one semester. In the full-time form, students attend one ninety-minute session per week. In the combined form, distance learners have twelve 45-minute lessons per semester with self-study support. In particular, we use methods of creating

and analysing mind maps, word clouds, group discussions, working with text, presentations and moderated debate. Work in the seminar results in the production of essays or reflections.

This research was based on essays written by students at the end of the Business Ethics course at FIM UHK. The students were asked to choose a significant topic dealing with some aspect(s) of business ethics. They were asked to think about this topic with respect to the course content and elaborate it into an essay or reflection on the topic.

The authors applied text analysis to their students' essays/reflections. The collected essays were thoroughly studied by BE teachers who looked for relevant ideas in the submitted essays/reflections. These ideas were then ranked based on the frequency of their occurrence in the students' essays/reflections. The results of this analysis were then evaluated in terms of their relevance to current requirements for teaching ethics.

3. Results Teaching Business Ethics at FIM

In the period 2020-2022, FIM students submitted 127 relevant written papers/essays (82 by full-time students and 45 by distance learners). Their choice of essay topics (see Table 1) was based on the syllabus and on debates and discussions in seminars.

Table 1. The most frequent topics of students' essays

Topic	No. of essays by full-time students	No. of essays by distance students
Determinants affecting job satisfaction	48	36
Ethical aspects of communication in workplace relationships	18	2
Code of ethics	6	2
Inappropriate behaviour in the workplace	5	2
Fair Trade	3	2
Ethics of persuasion	2	1

Learners could also formulate their own topic. Some of the most frequently analysed topics include, for example, determinants of job satisfaction, ethical aspects of communication in workplace relationships, codes of conduct, inappropriate behaviour in the workplace, fair trade, and ethics of persuasion.

Students are most interested in issues related to employment, professional performance and workplace relationships. Based on frequency analysis (see Table 2), the most common themes have to do with the determinants of job satisfaction: fair financial remuneration, adequate job placement, work environment, and relationships with colleagues/co-workers.

Students seem to prefer to view ethical issues from a personal perspective or from the perspective of the individual and his/her position in the workplace. From the students' point of view, the personal interest of the employee seems to be essential, which also applies to negative influences. Among the latter, the students include maximalist demands of the employer, unreasonable workload, stressful environment, constant control of employees, harassment, bullying and ageism.

Table 2. Frequency analysis of the most often mentioned ethical motifs in students' essays

Motif	No. of essays mentioning the motif
fair financial remuneration	82
adequate job placement	79
work environment	75
relationships with colleagues/co-workers	75
clear organizational structure	68
quality of management	68
benefits	65
meaningful work	65
variety of work	63
job satisfaction	61
clear definition of duties and responsibilities	57
opportunity for personal growth	54
career development	54

On the other hand, students seem to neglect the corporate perspective. There is no or very little consideration of whether the company as a whole behaves ethically, whether the products and services it offers meet the expected ethical standards, stakeholder relations are hardly mentioned. In the future, from this perspective, the corporate view of ethical issues should be much more emphasized in the teaching of business ethics.

Concerning ethical aspects of communication in workplace relationships, the students emphasize the importance of correct and polite language, respect for communication partners, helpfulness, kindness, ability to listen to others, avoiding misunderstandings, paying attention to the appropriate form and content of communication, not underestimating disputes, and rejecting verbal bullying.

In contrast to the previous point, here, at least in some cases, the corporate view is present (e.g., refrain from making disloyal statements about the company, do not bring out internal information).

Regarding the topic of the code of ethics, the students consider it essential that the code is clear and understandable, that employees are encouraged to participate in its development, and that it focuses on the common interest of the company, organisation or institution. The corporate view is not neglected here, either. Moreover, the essential motif of interdisciplinary dialogue, which is widely emphasized in contemporary applied ethics (see, e.g., Shih et al., 2021; Solomonides et al., 2022; Stenseke, 2022; Hu et al., 2022; Leimanis & Palkova, 2021), is evident. Nevertheless, it is also useful to emphasize other benefits of codes of conduct. Codes of conduct help promote fair business practices, honesty and respect for others and the law. At the same time, they ensure the quality of work as well as health and safety. They help resolve conflicts and unfair practices. Codes may prevent unethical and unfair behaviour and discrimination in the workplace. They improve the company's image and credibility and also serve as a basis for redress in the event of misconduct.

On the topic of inappropriate behaviour in the workplace, students often point out the unacceptability of rude, aggressive and sexually motivated behaviour. Again, the main emphasis here is on the personal perspective, whereas the corporate perspective (e.g.,

obeying the company's rules, effective communication, taking responsibility, accountability, professionalism), is neglected.

The topic of fair trade is considered by students to be insufficiently promoted. On the other hand, not the Czech Republic nor its predecessors have ever had any colonies and the attitude of the local population towards fair trade issues is therefore different from that of people in countries that have actively participated in the exploitation of colonized parts of the world. Still, Fair Trade is becoming more well-known in the Czech Republic, especially through multinational chains that distribute fair trade products.

The ethics of persuasion is, in the students' views, associated with the need for unobtrusive, fair dealing linked to a rational justification of the benefits of the goods or services offered. Theoretically, emotional appeals can be used ethically in order to get the audience involved. On the other hand, their excessive utilization used in place of evidence and logical reasoning is unethical.

All in all, the students' essays/reflections pointed to the most serious shortcoming of the BE course taught at FIM UHK, namely the lack of emphasis on the corporate level of ethics. Our students tend to focus on viewing ethical issues from a personal perspective, i.e., from the perspective of the employee and his/her position in the workplace. There are no essays/reflections that approach ethical issues from a corporate or societal perspective. This is problematic because the development of new technologies requires exploring ethical issues from different perspectives.

4. Discussion

The fundamental questions we asked in this research were: What are the shortcomings of our approach to teaching applied ethics? What should we change in the future to prepare our students well for their managerial work?

Our findings suggest that we should focus much more on the corporate perspective of business ethics. It would also be useful to use suitable case studies to show how typical ethical issues of today can be addressed. A particularly appropriate example is the application of new technologies, which bring with them a number of new ethical challenges. These cannot be solved by individuals, as their solution requires a broad discussion between multiple stakeholders with different perspectives. Particularly useful might be to show examples of ethical problem solving that include conflicts between ethical principles, exemplified by medical ethics (e.g., Varkey, 2021). It is not a matter of completely changing the approach to teaching business ethics. Rather, it should be enriched with case studies suggesting possible solutions to real problems that not only healthcare professionals but also managers may encounter.

Of course, our study is limited because students could not choose reflecting on multiple topics. Moreover, from their perspective, writing about ethical issues from their own perspective was certainly easier than considering a variety of different approaches. On the other hand, we consider it essential that students understand that there is not only the employer's responsibility to the employee, but also a responsibility and accountability to other people, including the company's shareholders, customers, suppliers, and ultimately to the local community and society as a whole.

5. Conclusions

We dare to claim, teaching ethics to future managers is increasingly desirable. Various projects on the introduction of new technologies and other means for the potential improvement of human life contain chapters dealing with the ethical implications of such changes. From this perspective, it seems that the path we have chosen at the FIM UHK, i.e., introducing students to basic theory and then, in particular, solving case studies and students' own reflecting on tricky ethical topics, is an appropriate way to awaken and subsequently deepen their ethical awareness. The near future is likely to be much more favourable to ethical practice than the recent past.

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How to Work with Generation Z: Cluster Analysis Based on Emotional Intelligence of University Students

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Abstract: This paper aims to map the level of emotional intelligence (EI) among Generation Z. The research is based on a questionnaire survey devoted to EI and conducted among second-year bachelor students. The questionnaire is built on the theory of David Goleman, who divides emotional intelligence into five competencies: self-awareness, managing emotions, motivating oneself, empathy and social skills. Based on the results of particular dimensions of EI and gender, 130 students were divided into three subgroups using cluster analysis. From the evaluation of the results, most of the observed sample of Generation Z in general shows high potential in managing and using emotional intelligence. Nevertheless, there are areas that members of Gen Z and (future) managers should focus on. There are especially: managing emotions, getting along with others (social skills), and developing self-motivation.

Keywords: emotional intelligence; Generation Z; cluster analysis

JEL Classification: O15

1. Introduction

Understanding Generation Z (Gen Z) members and working with their emotional intelligence (EI) already play and definitely will play a key role in future managerial work and their appropriate integration into the work process. Individuals of Generation Z were born in 1995 and later and grew up (or still grow up) in a completely different environment than previous generations. And managers and leaders must count on it. Nowadays, managers are expected to do much more coaching than directive management (Fiori & Vesely-Maillefer, 2018). Within leadership, members' high degree of participation in the assigned task is assumed. And the emphasis is placed on well-being when achieving the set objectives. During the entire process, managers must be able to respond flexibly (not only) to the personal changes of subordinates (Grant & Spence, 2010). Coaching has been found to provide emotional support and reduce employee stress. At the same time, it significantly affects achieving goals and increases psychological well-being at the workplace (Theeboom et al., 2014).

However, a large part of the Gen Z members is still studying at universities. Therefore, even teachers can incorporate new approaches and methods of action into teaching. For example, a study published in 2020 investigated the effect of emotional intelligence among university students on their ability to deal with stress. Based on their research, the authors

strongly recommend that professors study the concept of emotional intelligence and methods of stress management in detail in order to be able to provide students with guidance on how to best deal with stress. (Fteiha & Awwad, 2020).

The research presented in this paper examined the emotional intelligence level of 130 university students in November 2022. It was conducted within seminars Introduction to Management among students in the second year of two bachelor study programs: Business Economics and International Economic Relations at the Faculty of Economics of the Technical University in Liberec. All respondents can be included in the so-called Generation Z, which is most often defined by the date of birth after 1995 (somewhere after 1997).

And how to briefly characterize this generation? These young people have already been born into a strongly globalized world, and the primary mean of communication for them is image (the prior generation Y communicates with words, e.g., the previously popular SMS). This generation can boast technological skills and is naturally oriented towards social networks (Machová et al., 2020).

Furthermore, it is precisely this technological progress, so characteristic of the overall development of our society, that contains new realities typical for the growing generation. Generation Z is characterized by a paradoxical feeling of loneliness when people are part of constant online communication but lack personal contact in real life (Seemiller & Grace, 2016). And in a world where devices and robots already perform many repetitive tasks based on artificial intelligence, it is frequently challenging for them to engage emotional intelligence. However, EI represents the main advantage with which fully automated devices can compete (Schuller & Schuller, 2018).

In order to fulfil the goals of this study, the presented paper follows this structure: In the first part, the literature review is devoted to a brief history of the concept of emotional intelligence with an emphasis on Goleman's approach and essential features of Generation Z are also briefly defined. The methodology section presents a selected questionnaire and aptly characterizes the investigated group. The selected statistical method - cluster analysis - is also commented on. Subsequently, the results of the cluster analysis are presented. In the final part - the discussion, proposed recommendations on how to work with individual groups (clusters) are mentioned. Within the defined clusters, the summary points out their strengths and weaknesses and offers possible approaches how to work with particular clusters. At the very end, the authors mention the limits of the presented research and outline future opportunities for further research.

2. Literature Review

Literature search briefly summarizes fundamentals of emotional intelligence and essential characteristics of Gen Z.

2.1. Emotional Intelligence

Emotional intelligence was first recorded in Michael Beldoch's publication, published in 1964. He characterizes EI as the ability to recognize the emotions of oneself and others as well as many other authors. Additional aspects of the art of working with emotions include their

control and adaptation of one's expression according to a given goal or problem solution (Davitz & Beldoch, 1964).

David Goleman is considered the most important promoter and popularizer of emotional intelligence. With his book Emotional Intelligence, he started a discussion about the growing importance of EI. In the title, he questions whether EI is even a more critical component of intelligence than the more well-known and much more comprehensible assessment of intelligence – IQ (Goleman, 1995). Its first edition points to the well-being of both high-IQ and low-IQ people. Based on a new approach to brain research, he indicates the factors that determine overall personal success. He groups them under the term emotional intelligence. According to him, EI includes, among others, self-awareness and impulse control, persistence, enthusiasm and self-motivation, empathy and social dexterity (Goleman, 1995).

Subsequently, as management approaches also changed from a directive one with an emphasis on performance to a more liberal one with an emphasis on people, the term EI appears more and more often in publications. For example, in 1997, the connection between emotional intelligence and stress management was first identified and presented, emphasizing an individual's successful growth and development. The optimal use of EI enables a better understanding of one's feelings and emotions, leading to better self-control, and the given person can manage their actions better (Salovey & Sluyter, 1997).

In the following years, countless authors dealt with the concept, measurement and involvement of emotional intelligence. Regarding the research part of this paper, the division of emotional intelligence into competencies is further characterized, as defined by Goleman in the later edition of his book (2011). EI can be understood as the ability to comprehend and manage our emotions and those around us. These fundamental elements can be subdivided into the following five skills (Machová et al., 2020; MindTools, n.d.; Goleman, 2011):

- Self-awareness primarily means being aware of how one feels in every situation and being fully aware of the responsibility for the actions that one's behavior and emotions can cause. It is essential to know own strengths and weaknesses very well and to be able to use them properly or to maintain humility.
- Self-regulation or managing emotions suppose people are capable of a high degree of self-regulation. In that case, they do not tend to react irritatedly to others, make emotional and hasty decisions or pigeonhole others according to familiar stereotypes. Put, managing emotions is all about maintaining control.
- Self-motivation is critical in achieving personal goals or completing the learning process. As part of team management, it is necessary to set a positive example and thus motivate others. The high standards of one's work are easier to transfer to others.
- Empathy. Individuals with a high degree of empathy can more easily put themselves in someone else's situation. As part of the work process, empathetic behavior enables the personal development of individuals. It provides constructive feedback, and the so-called open-door principle of listening to management-level problems works here.
- Social skills. The most challenging discipline can be described as managing interpersonal relationships. This skill can be honed while gaining experience in interpersonal

communication. Other than through social contact, these abilities cannot be trained. Individuals who are good at emotional intelligence and social skills are excellent communicators. Within the team, they convey both good and bad news and can get others excited about a new project or strategy.

2.2. Generation Z

Several other designations of the generation whose members were born after 1995 (some authors also mention 1997) can be found in publications, for example, post-millennials or iGeneration. However, it most often enters the public consciousness as Generation Z (Dimock, 2019). The naturalness of technological development can be identified as the main feature accompanying almost all studies and comments devoted to Generation Z. Paradoxically, members of Gen Z are often more experienced in using technology than their parents. Thus, there is no traditional transfer of learning from the older generation to the younger. This generation is surrounded and equipped with technological devices from early childhood.

Not only technological progress but also social networks accompany their whole lives. The first Apple was released in 2007, Facebook entered the market in 2004, and many others, such as Instagram, Pinterest and Tik-tok, have gained popularity since then (Berkup, 2020). Therefore, continuous connectivity and constant communication are entirely natural for this generation. The constant supply of new information and the possibility of continuous connection with anyone from anywhere represents a new burden that the new generation has to cope with: multi-tasking, information overload or excessive consumption of online content (Gui et al., 2017). However, compared to the previous generation, they know the pitfalls of spending time online. Almost 60% of users would like to limit their time on social networks, and 38% even consider logging out completely (Deloitte, 2019).

3. Methodology

The main goal of this study is to exploit cluster analysis to point out possible differences between members of Generation Z in emotional intelligence and their subcomponents. Presented research divides respondents into several groups according to gender and self-assessment of skills falling under EI. The research was conducted using a questionnaire based on the theory of David Goleman (2011). He divides emotional intelligence into five competencies: knowledge of one's own emotions (self-awareness), managing emotions, motivating oneself, sensitivity to other people's feelings (empathy), and the art of interpersonal relationships (social skills) (Goleman, 2011).

Based on the above, this study endeavors to answer the following research questions:

1. What is the level of emotional intelligence in the studied sample of Generation Z?
2. How does the level differ in individual EI competencies?
3. Can the research sample be divided into clusters based on gender and EI level?

3.1. Survey

Self-assessment of emotional intelligence was built on a questionnaire based on David Goleman's theory. In total, students responded to 50 statements using a scale of 1-5 where:

- 1 meant that the statement does NOT apply to them,
- 3 meant that the statement is true in approximately half of the cases,
- 5 meant that the statement ALWAYS applies to them.

Respondents then rewrote their scores (1-5) for individual statements in the table. The layout in the table was clearly organized into five columns according to the individual emotional competencies defined by Goleman. Based on the final score, the results can then be interpreted according to Table 1.

Table 1. Interpretation of results

Score	Guide
35-50	This area is a strength for you.
18-34	Giving attention to where you feel you are weakest will pay dividends.
10-17	Make this area a development priority.

The survey involved 130 students, 78 women and 52 men, all aged 20-21. The research was conducted as part of the Introduction to Management course, taught in the second year of the bachelor's study programs Business Economics and International Economic Relations.

The temperament distribution was also examined using the Eysenck test to supplement the general overview of the respondents' character traits. The students were divided into groups according to their level of extroversion and emotional lability (stability). The combination of these two dimensions creates four types of human personality: sanguine, phlegmatic, choleric and melancholic (for more see, for example (Sato, 2005). Table 2 shows the results of the research sample.

Table 2. Distribution of character types in the sample

Temperament types	Total frequency	Relative frequency
Phlegmatic	14	11%
Choleric	30	23%
Melancholic	60	46%
Sanguine	26	20%

3.2. Cluster Analysis

Under the term cluster analysis, it is possible to find a variety (hundreds) of mathematical methods that can be used to find out which objects in a group are similar. Instead of sorting real objects, these methods sort objects described as data. Objects with similar descriptions are gathered into the same cluster (mathematically). The hierarchical methods are most widely applied in research studies (Romesburg, 2004).

Hierarchical cluster analysis is characterized as a sequence of decompositions, where on one side there is a cluster containing all objects and on the other side single element clusters. This method is better applied in finding structures rather than searching for new patterns. Hierarchical clustering can be represented using a binary tree, a dendrogram. Nodes in the dendrogram show individual clusters.

Further subdivision of hierarchical agglomerative methods is based on the criterion according to which the most similar clusters are selected. The complete linkage (furthest neighbor) method is applied in this study. This method combines objects or clusters that are furthest apart within a sorted dataset into a single burst. This means that for the distance of two clusters it takes the greatest possible distance from the distances of every two objects from two different clusters. From the calculated distances, it selects the shortest and connects the corresponding objects. It forms tight clusters of approximately the same size (Kučera, n.d.).

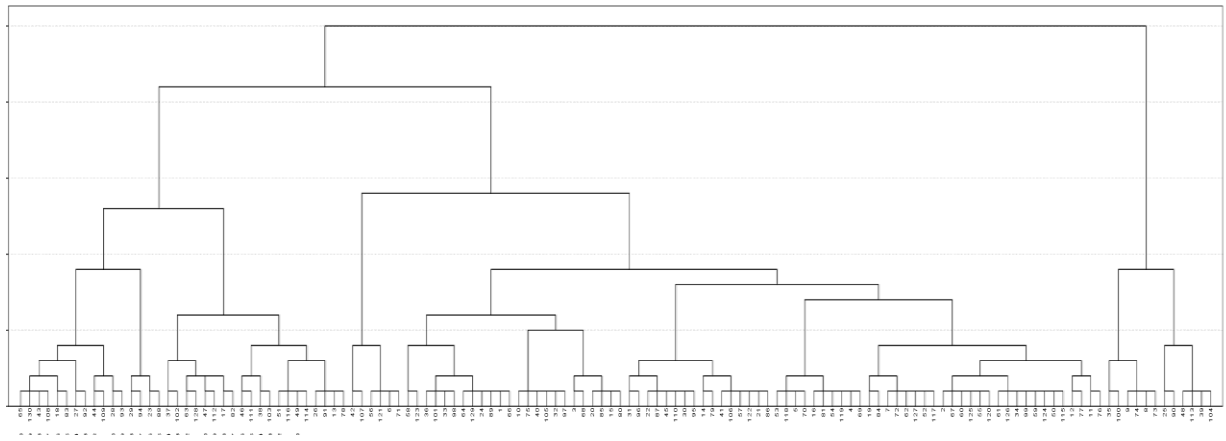
Clustering in the presented study was performed in IBM SPSS Statistics 27 using hierarchical clustering, the furthest neighbor method.

4. Research Results

The graphic result of the cluster analysis can be found in the literature under the term dendrogram. This diagram demonstrates a hierarchical relationship between objects. Therefore, it belongs to the most common outputs from hierarchical clustering. Working from the bottom up, the dendrogram shows the sequence of joins that were made between clusters. Lines are drawn connecting the clusters that are joined at each step, while the vertical axis displays the distance between the clusters when they were joined (Statgraphics Technologies, n.d.).

According to the dendrogram, the best way to allocate objects into clusters can be found. One option for determining the optimal number of clusters is, thus, using a graphic representation – a dendrogram (Cichosz, 2015). A dendrogram representing the obtained data is shown in Figure 1.

Figure 1. Dendrogram of obtained data



The objects were clustered according to 6 variables: gender and the final score (0-50) for the five EI competencies obtained in the questionnaire survey. Due to the number of respondents and the data analysis, the variant with 3 clusters was found to be the most suitable. Table 3 contains the frequency of both sexes and the average values of self-assessment in individual components of EI.

For better clarity and interpretation of the results, the individual values were converted into verbal expressions according to Table 4, resulting from the used questionnaire toolkit. Table 4 summarizes the outputs.

Table 3. Averaged values of EI for each cluster

Clusters	Female	Male	Self-awareness	Managing emotions	Motivating oneself	Empathy	Social skills
1	50	32	37.6	27.5	29.5	35.8	31.6
2	6	6	27.2	28.7	31.5	28.8	22.2
3	22	14	36.0	33.5	36.8	39.4	35.8
Σ/Ø	78	52	36.2	29.3	31.7	36.2	31.9

Table 4. Results of cluster analysis in verbal expression

Clusters (Nr. of objects)	Female	Male	Self-awareness	Managing emotions	Motivating oneself	Empathy	Social Skill
1 (82)	50	32	Strength	Giving attention	Giving attention	Strength	Giving attention
2 (12)	6	6	Giving attention	Giving attention	Giving attention	Giving attention	Giving attention
3 (36)	22	14	Strength	Giving attention	Strength	Strength	Strength
Σ/Output	78	52	Strength	Giving attention	Giving attention	Strength	Giving attention

5. Discussion

In the first phase of the research, the main intention was to examine the general level of emotional intelligence among the respondents and, subsequently, the level of EI in individual competencies. Based on the results summarizing values across all clusters, the strengths of EI in the studied sample of generation Z can include the ability to self-control and empathy, i.e. the ability to empathize with the feelings of others quickly. These competencies were equally rated at 36.2. The other three areas of EI should be paid attention to by members of Generation Z when trying to develop themselves.

Overall, emotional intelligence training should become a fixed part when setting educational goals. The average EI level reached a value of 33. The results correspond with similar research conducted in 2019 in Slovakia and Hungary. It was found that although Generation Z considers emotional intelligence more important than the cognitive component, it still shows lower emotional intelligence than their older (Baby Boom, Generation X and Y) counterparts (Machová et al., 2020). The variance between moderate and high levels of EI was also measured in study conducted among Indian university students. It was carried out in 2019 and examined a selected sample according to gender, age, place of residence (city x rural) and type of study (Kant, 2019).

The third research question dealt with the possible division of the studied sample into several groups. The evaluation of the individual clusters shows that, although in the strongest cluster No. 3 (in terms of measured EI level), where 4 out of 5 components of emotional intelligence can be described as a strength, the members of this group still have to work on their control of emotions. This information is also crucial for managers, future leaders and teachers. They must remember the importance of working with this sub-area with their new young subordinates, recent graduates or students.

In the numerically most robust cluster No. 1 (82 members), efforts to better manage interpersonal relationships also come to the forefront of the development activities. It corresponds to a weaker level of emotion management across all clusters. These two categories in targeted training can be linked so that managing one's emotions contributes to better relationships and dealings with other team members. Last but not least, for members of this group, managers must pay attention to developing their motivation. It is where the much sought-after coaching style should come into play, as presented in the introduction. It focuses on people as individuals and not on the performance itself. It thus motivates workers or students to get involved and engaged in a given project or task (Theeboom et al., 2014).

The greatest attention and interest of superiors regarding the EI progress should be directed towards cluster 2. Emotional intelligence does not reach the level of strength in any of the measured competencies. Nevertheless, the good news for management is this cluster's total number of members. In the examined sample, only 12 respondents, i.e. less than 10% of the respondents, were included. Individuals in this narrow group show the highest level of EI (31.5) within the self-motivation skill. However, getting along with other people is their most serious difficulty. In this case, managers can consider assigning separate tasks and gradually integrating them into the team.

6. Conclusion

The presented paper aimed to evaluate the current level of emotional intelligence in the emerging and work-starting generation – GenZ. Possible areas of analysis were identified using three research questions. Regarding the first of these: *What is the level of emotional intelligence in the studied sample of Generation Z?* based on the evaluation of the Goleman test, authors conclude that a large part of generation Z shows a high potential in managing and using emotional intelligence. However, the average value of 33 (out of a maximum of 50) indicates the requirement for further training and education. The second research question sought an answer to which components of emotional intelligence to focus on in personal development: *How does the level differ in individual EI competencies?* Thanks to a more detailed analysis, it was feasible to define areas with a higher priority: managing emotions, self-motivation and interpersonal relationships. On the other hand, the strengths of the studied sample included self-awareness and empathy.

The final third question examined the possibility of dividing the members of Generation Z into homogeneous groups: *Can the research sample be divided into clusters based on gender and EI level?* Within cluster analysis, three significant homogeneous groups showing very similar characteristics were defined. These were explicitly presented for individual clusters. The main outputs of the work were able to answer all the set questions. However, several other options exist for following up on the presented study.

This essential pilot research can be followed up by expanding the examined sample to other university fields and adding variables such as current workload, family circumstances or place of residence. Therefore, the narrow focus of the analysis can be considered as a limit of the presented research. Despite this, it helped get an initial idea of the current generation's

EI level. As for the research itself, in the future, the authors can concentrate on individual EI competencies and, for those with the lowest measured levels, suggest possible methods and approaches to improve these values among members of Generation Z.

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What Fields of Management Are Affected by Industry 4.0 And What Changes Are Coming with It?

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Abstract: Organizations are facing increasing pressures from the external environment. New changes are constantly coming, and businesses must learn to respond to the changes. One of the most significant dynamic changes of the present time is Industry 4.0, bringing a huge number of new technologies, innovations and which fuels the issue of sustainability and sustainable development. The main aim of this paper is to conduct a systematic literature review of Industry 4.0, find out what changes are occurring, and which fields of management are most affected due to this. To fulfill this aim, the PRISMA 2020 guideline for systematic reviews has been used. It was found that most affected fields are process, change and human resources management. Issues of employee´s skills, knowledge and development are highly discussed. Workplace 4.0 leadership skills and value chain is also mentioned. Last, but not least the keywords analysis has been done. It was observed that mostly occurred words are Industry 4.0, innovations, management, technology, CSR or workplace.

Keywords: Industry 4.0; management; change; change management; innovations; systematic review

JEL Classification: O31; O32; M10

1. Introduction

Industry 4.0 concept is developing more and more. In recent years, new technologies have been constantly emerging. Nowadays, this concept is not only about Big data, IoT, Artificial Intelligence, virtual reality, robotization, automation, digitization or Smart factories. As Kowalikova (2020) reminds, this concept was first mentioned in the strategies of developed economics, e.g. Germany, US or Japan. But very first this term was used in German in 2011 (Lenart-Gansiniec, 2019). Therefore, several perspectives on this concept are now offered. Some authors say that Industry 4.0 is purported to be a new paradigm of smart and autonomous manufacturing. (Bai et al., 2020). Ullah (2020) offers this attitude: In Industry 4.0, humans, technology, and organizations are integrated in both horizontal and vertical manners using advanced information and communication technologies. Obermayer et al. (2022) claims that Industry 4.0, a German strategic initiative, is aimed at generating a transformation from machine-dominant manufacturing to digital and intelligent manufacturing. As is quite evident, there are many definitions and contexts.

Industry 4.0 is not only about technology, the question of sustainability and sustainability development is being extremely discussed. Corporate social responsibility including triple bottom line is now inseparable part of social responsibility of companies. Companies are currently facing pressures to implement the principles of the social responsibility. The issues of waste-free and emission-free production, quality of working environment and work conditions are mostly addressed (Cohran & Rauch, 2020). These pressures are also strong from supranational groups such as the European Union. These new changes have to be implemented through number of fields of management. The basis of each change is successful change management, which can be effectively used in any functional field of the company (Paraschiv et al., 2019).

2. Methodology

The main aim of this paper is to find out what management fields are more affected by fourth industrial revolution called 'Industry 4.0'. This concept brought many great changes and as entry into research a review is conducted. It may help to understand what articles are dealing with and what topics are the most researched nowadays.

The Paper is based on PRISMA 2020 guideline for reporting systematic reviews (PRISMA, 2021) as it is required. The research was done on 5th December 2022. All articles were searched in the Web of Science database. Primary criterium for searching was the Topic which was stated as 'change management AND Industry 4.0'. This topic was chosen because the main aim of this paper is to find what changes is Industry 4.0 bringing and what management fields are affected by this concept. Other criteria were then applied. First of all, articles that were not available in Open Access were discarded. Afterwards records that were not article or proceeding paper and were not available in English were discarded. Last, but not least Citation topic was selected, and it was stated as 'Management'. In the end concrete fields were chosen and correct fields were defined as: Management, Business, Green Sustainable Science Technology, Economics, Industrial Relations Labor. According to the number of records it was not necessary to apply a restrictive criterion according to the year of publication. 26 papers were selected to full paper revision. Unfortunately, 10 articles did not fit the field, so it was necessary to discard them. In one case, only manufacturing reshoring was solved, and Industry 4.0 was only particular part of this paper. Then other paper solved only risk management and not management or Industry 4.0 as a topic. Third article did deal only with social change and not change as part of management. Fourth paper was focused on innovations at all, with no connection to Industry 4.0. Then, other paper did solve work conditions in manufacturing enterprises, but with no connection to management, change management or Industry 4.0. Two papers solved only particular economic impact and remaining two articles were focused on innovations dealing with Industry 4.0, but only in covid-19 pandemic time, so it was decided to discard them as well. One paper was discarded because of duplication.

Furthermore, the keywords analysis has been done. It was done manually, and the result of this analysis was the word cloud, where the font size shows how often the concrete keyword occurs.

3. Results

Before the whole full paper review will be described, the results of keyword analysis are offered. For this analysis the method of word cloud was chosen. The font size shows how often the concrete keyword occurs (Heimerl et. al., 2014). For better imagination on all related topics, keywords from all originally filtered 26 articles were used for this analysis. According to this analysis, there can be identified topics that are the most connected with Industry 4.0. These topics are Innovations, Technology, TQM, Project/Project Management, SME´s, Management/Change management, ERP. As Figure 1 shows, there are many other topics connected with Industry 4.0. According to this keyword analysis, the own definition of Industry 4.0 had been made. Authors defines Industry 4.0 as "A constantly developing technological concept including a whole range of new innovations affecting a whole range of fields in management and economics with the potential for further growth". It is obvious that this concept is connected to other modern trends like TQM or ERP, but it is clear these trends are not directly the result of Industry 4.0. Selected keywords that had a frequency of at least 2 are listed in Table 1 for ease of reference.

Figure 1. Keyword cloud

Table 1. Keywords frequency

Keyword	Frequency
Industry 4.0	11
Innovations	5
Management	4
Technology	4
Project	2
Manufacturing enterprises	2
Digital transformation	2
Human capital	2
SME	2

As it is mentioned in chapter Methodology, this review is based on PRISMA 2020 guideline. The review is made of 16 articles that were chosen from original 1,076 results. The whole process is illustrated by Figure 2 and described in chapter Methodology.

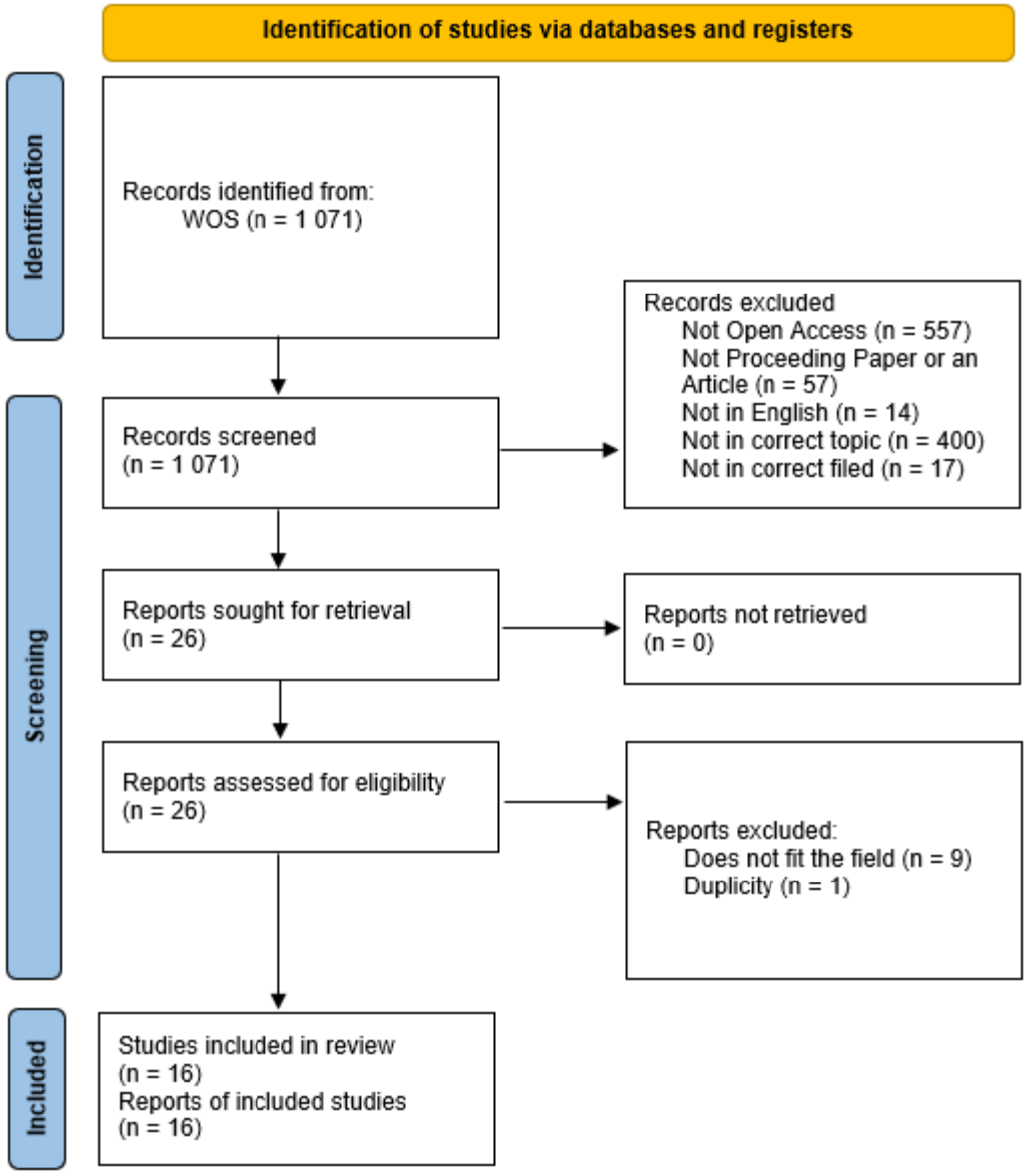

Figure 2. PRISMA 2020 diagram (PRISMA, 2021)

There were 1,076 original records. From this records, 557 records were excluded because they were not available in Open Access, 57 due to the wrong type of paper, 14 due to the wrong language, 400 due to the wrong WOS Citation topic and 17 due to the wrong field. 26 reports were selected for full paper review. Then, other 10 papers were discarded due to the wrong or not complete topic. Reasons for this discarding are described in Methodology. For this review 16 records were chosen. Basic characteristics (author, year, title, times cited and type of paper) are described in Table 2.

Table 2. Selected papers

	Author and Year	Title	Times cited	Type
1.	Whysall et al. (2019)	The new talent management challenges of Industry 4.0	57	Article
2.	Efimova & Bris (2021)	Quality 4.0 for Processes and Customers	1	Article
3.	Klovienė & Uosyte (2019)	Development of Performance Measurement System in the Context of Industry 4.0: a Case Study	8	Article
4.	Stachowicz & Nowicka-Skowron (2019)	Opportunities and threats to the functioning of contemporary socially responsible enterprises organized according to the concept of 'Industry 4.0'	3	Article
5.	Lin & Wang (2022)	Talent Retention of New Generations for Sustainable Employment Relationships in Work 4.0 Era-Assessment by Fuzzy Delphi Method	1	Article
6.	Črešnar & Nedelko (2020)	Understanding Future Leaders: How Are Personal Values of Generations Y and Z Tailored to Leadership in Industry 4.0?	14	Article
7.	Pisar & Mazo (2020)	Controlling, communication and corporate culture – the opportunities for SME´s	7	Article
8.	Sansabas-Villalpando et al. (2019)	CODAS HFLTS Method to Appraise Organizational Culture of Innovation and Complex Technological Changes Environments	10	Article
9.	Szelagowski & Berniak-Wozny (2021)	How to improve the assessment of BPM maturity in the era of digital transformation	1	Article
10.	Vrchota & Řehoř (2019)	Project management and innovation in the manufacturing industry in Czech Republic	9	Proceedings Paper
11.	Jerman et al. (2019)	The Influence of Critical Factors on Business Model at a Smart Factory: A Case Study	9	Article
12.	Sharma et al. (2022)	Analysing the impact of sustainable human resource management practices and industry 4.0 technologies adoption on employability skills	4	Article
13.	Perkins et al. (2022)	Analysing the impacts of Universal Basic Income in the changing world of work: Challenges to the psychological contract and a future research agenda	4	Article
14.	Heubeck & Meckl (2022)	More capable, more innovative? An empirical inquiry into the effects of dynamic managerial capabilities on digital firms' innovativeness	1	Article
15.	Tick et al. (2022)	Conscious or indifferent – concerns on digitalization and sustainability among SME´s in Industry 4.0	0	Article
16.	Potoczek (2021)	The use of process benchmarking in the water industry to introduce changes in the digitization of the company's value chain	2	Article

Figure 3 shows publications and citations of 26 original searched records.

Potoczek (2021) solved a question of benchmark methodology for digitizing the value chain. This research identified that since 2006 the progress of digital maturity researches is significant. Especially last four years there is a dynamic increase of acknowledgement. The author defined a way how to improve the process of benchmarking according to digital technologies and how to obtain the higher digital maturity level. Author also mentioned the fact that digitization of value chain largely depends on digital skills of employees as well as AI, IoT or cloud computing. Economic and productivity growth is not forgotten. Process

management is the main topic solved by this study, especially focused on process maturity, digital maturity 4.0 and digitization of value chain. The paper did not bring any fundamental real-world utilization.

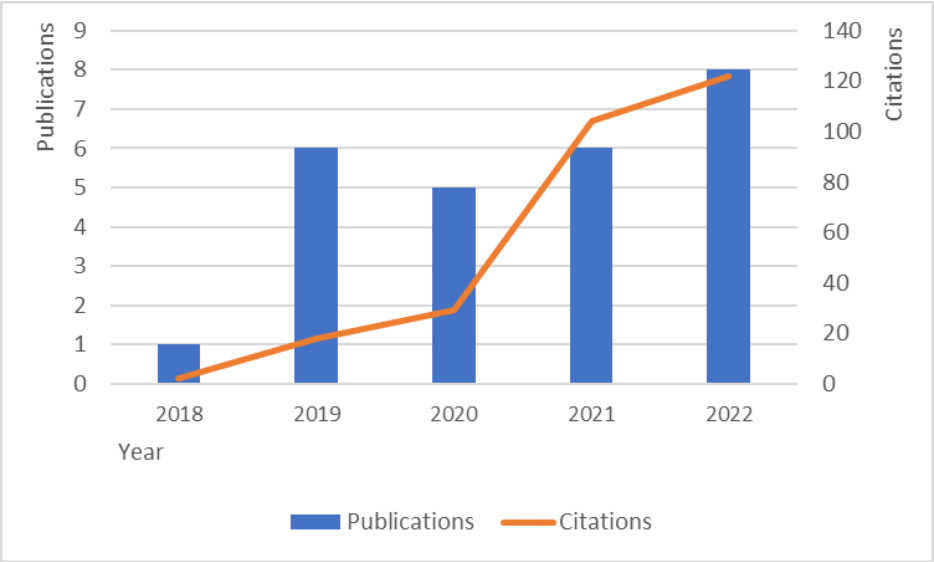

Figure 3. Publications and citations of publications

Vrchota and Řehoř (2019) are interested about a role of project management in a question on innovation and investment at all. In fact, companies applying project management are more innovative than other enterprises. There was found the dependence between project management and size of investment according to two-tailed Fisher test. Unfortunately, greater development of project management in enterprises is limited mostly by lack of skilled employees. Project management and particular HR management had been solved in this study. The research was done on 164 manufacturing enterprises in Czech Republic.

Pisar and Mazo (2020) made the research on 826 SME´s enterprise from European Union. It was proved that change management and Industry 4.0 are one of the most affecting factors for companies controlling. This article highlights the importance of change management because nowadays the continuous improvement and changes are required. Also is mentioned that companies are usually ready to invest in technology etc., but investment in management and change management are low.

Whysall et al. (2019) study brought interesting findings. Industry 4.0 made a huge difference between actual employee capabilities or competencies and new requirements according to new technologies. It offers solution in way of transforming talent management. New skills-set are required, and companies HR departments are still not available to react adequately. It is necessary to made talent management more dynamic and become a part of strategic human resources management.

Jerman et al. (2019) at first describes concept of Smart factory and Industry 4.0 at all. Business models are characterized as well. Three main changes of the business model had been defined. It is automation (or digitization, robotization), integration of employees, products, and machines and last, but not least redefinition of roles of employees, machines, and products. The crucial factors for developing new business model are also mentioned. It

is leadership and top management, innovations, collective wisdom, and employee´s motivation. It is important to note that this research was limited by only one case of a smart factory. The future research scenario is offered.

Heubeck and Meckl (2022) focused on dynamic managerial capabilities in connection with innovations and Industry 4.0. This research was done in 2019 on sample consisting of 2,920 German Industry 4.0 companies. Firm innovativeness was stated as dependent variable, the independent variables was stated as (i) managerial human capital, (ii) managerial cognition and (iii) managerial social capital. Six control variables were also defined. It was found out that managers with more dynamic managerial capabilities are supporting digital firms´ innovativeness. Another question for HR departments had been offered.

Tick et al. (2019) investigates the dependence between digitalization on sustainability. 636 SME´s companies from 6 countries participated on this research. Two partial results are offered. At first, it is confirmed, that SME´s are not so open about question of sustainability or sustainable business models. More than half of a sample do not have sustainable goals in their long-term strategy. But according to second result, exploring or enabling of sustainable digitalization/digital sustainability had been proved. The authors defined term 'Digitainability'. The effect of digitalization and new technologies on sustainability had been proven. As authors mentioned, the results of this research cannot be generalized because of not enough representative sample.

Efimova and Bris (2021) examined the concept Quality 4.0 and TQM in closely connection to Industry 4.0. Especially the Industry 4.0 influence on Quality 4.0 had been solved. Two research question were established. It was found out, that modern technologies can significantly increase the quality management. Modern technologies, like IoT, machine learning and Big data made available large data stores and these stores are driving force for quality management. Process management transparency is not forgotten. The important role of Quality 4.0 in new quality management system had been mentioned. Second part of research was focused on customer satisfaction according to quality management change. It was proven that new technologies can improve the relationship between company and its client/his satisfaction.

Klovienė and Uosyte (2019) discovered that firms are using Industry 4.0 technologies to improve internal (logistics, production) and external (customer satisfaction) processes. It was also analyzed that in different Industry 4.0 clusters the different technologies are applied. Four most important benefits resulting from Industry 4.0 were defined as (i) cost saving, (ii) resource saving, (iii) faster processes and (iv.) improvement of products. It is also mentioned that Industry 4.0 had a great impact on company´s value and supply chain. Several fields had been described as crucial, e.g. logistics, supply chain.

Sharma et al. (2022) examined the field of sustainable human resources management and Industry 4.0. The main aim was to find out if these factors are affecting the employability skills. Four main practices of HR management were chosen as crucial – flexibility, training, employee participation and employee empowerment. 198 employees answered the survey which was limited to North India. It was proven that all 4 practices had significant efficiency on employability skills. But the most significant factor is Industry 4.0 with new technologies.

Great and fast changes in environment are the reason of changing working conditions and requirement for staff.

Perkins et al. (2022) discussed – as the only ones – new concept that is also related to Industry 4.0 and fourth industrial revolution – Universal Basic Income. New HR policies and development is being discussed. But this paper does not include any qualitative or quantitative research method. Only thoughts and ideas are offer and no data had been collected.

Stachowicz and Nowicka-Skowron (2019) primarily defined 6 advantages and 9 threats created by new technologies and their using in company´s processes. Concept of SMART organization is discussed. Authors formulated conclusions for management model based on Industry 4.0 on three pillars – (i) positive organizational scholarschip, (ii) the team with leaders is main management entity and (iii) new technologies, values and methods including management instrument must be integrated.

Lin and Wang (2022) discussed a question of talent management, Work 4.0 and impacts of new technologies on talent retention across different generations. The main outcome of this study can be identified as a fact that different generations (baby boomers, X and Y) are differently affected by new technologies and by concept Work 4.0. Furthermore, it was obtained that impacts of Work 4.0 and Industry 4.0 is the highest for generation Y. Another interesting fact is, that talent retention and talent management is different among different generations. It will be necessary to change concept of talent management in near future because of new technologies. Knowledge management will become crucial skill as well.

Črešnar and Nedelko (2020) also examined workplace with effect of concept Industry 4.0 across different generations and future leader skills were discussed as particular topic. This study´s sample was created from 371 respondents. Result of this study can be slightly disturbing because it was obtained skills regarded nowadays are not reflected in Industry 4.0 workplace. There will be necessary to change approach of leadership in most companies. As authors mentioned, universal, benevolent, and self-transcendence personal values will be the most appreciated and in demand.

Sansabas-Villalpando et al. (2019) analyzed organizational culture in model involving Industry 4.0 technologies and innovations in six different management fields. Sustainable, developing, and innovative organizational culture was the result of this analysis. It was obtained that organizational management is the area with the greatest influence. Process management and knowledge management are also decisive elements. Based on this research it can be said that organizational culture taking into account new technologies and sustainability will be based on these three management fields.

Szelagowski and Berniak-Wozny (2021) as many other authors investigate the field of process and business process management in connection with Industry 4.0. Unfortunately, no real scenario is offered. But it is obvious that process management is inseparable part of new technology implementation.

All topics discussed are illustrated by Table 3. According to this, the most discussed topics are: (i.) process management, (ii.) human resources management, (iii.) skills of employees, (iv.) change management, etc.

Table 3. Discussed topics

Analyzed fields / Author (Year)	Value chain	Process management	Process maturity	Skills of employees	Project management	HRM	Change management	Controlling	Industry 4.0 workplace	Talent management	Business model	Smart factory	Leadership	Managerial capabilities	Sustainability	Quality management	Universal Basic Income	Knowledge	Organizational culture
Potoczek (2021)	✔	✔	✔	✔															
Vrchota & Řehoř (2019)				✔	✔	✔													
Pisar & Mazo (2020)							✔	✔											
Whysall et al. (2019)				✔		✔			✔	✔									
Jerman et al. (2019)							✔				✔	✔	✔						
Heubeck & Meckl (2022)						✔								✔					
Tick et al. (2019)		✔									✔				✔				
Efimova & Bris (2021)		✔					✔									✔			
Klovienė & Uosyte (2019)	✔	✔																	
Sharma et al. (2022)				✔		✔	✔		✔						✔				
Perkins et al. (2022)						✔											✔		
Stachowicz & Nowicka-Skowron (2019)		✔											✔						
Lin & Wang (2022)				✔		✔			✔	✔								✔	
Črešnar & Nedelko (2020)									✔				✔						
Sansabas-Villalpando et al. (2019)		✔													✔			✔	✔
Szelagowski & Berniak- Wozny (2021)		✔																	

4. Discussion

First, this paper was limited by one database source which was Web of science. It provides number of quality articles, but it is worth mentioning that number of relevant sources can be found in other databases. Main aim of this article is to evaluate actual knowledge about what Industry 4.0 technologies are changing in various management fields. There are number of possibilities for further research. This theme can be further developed in different directions, for example by focusing on a specific field such as human resources or talent management with the implementation of specific research.

Authors believe that the following can be identified as the main fields that are undergoing major changes – process management, change management, talent management, human resources management. These topics are closely related to other solved areas like Industry 4.0 workplace, skills, leadership, and sustainability.

Many authors see the main way of implementing Industry 4.0 and its impacts through process management. Process maturity is a strongly discussed topic, e.g. Potoczek (2021). On the other hand, connection between process management and quality management related to customer satisfaction is being discussed (Efimova & Bris, 2021). Klovienė and Uosyte (2019)

does not neglect the fact that processes are internal and external and that both types need to be improved and changed. Tick et al. (2019) does not forget to mention that the issue of sustainability must also be addressed in connection with processes and the business model. However, some authors perceive process management rather as a supporting field, e.g. Sansabas-Villalpando et al. (2019).

It is possible to find author who see the biggest changes in the field of work, e.g. Lin and Wang (2022). There will be much more different skills in demand, as Whysall et al. (2019) mentioned. The whole HR field will undergo drastic changes in near future. The leadership area will be very affected, as well as the area of talent management. Heubeck and Meckl (2022) analyzed very thoroughly the impact of Industry 4.0 on dynamic managerial capabilities. It was proven that major changes in the world of work will be needed.

All these changes and their implementation is based on quality change management. This fact was mentioned by Pisar and Mazo (2020).

5. Conclusions

The main aim of this paper was to find out what management fields are more affected by fourth industrial revolution called 'Industry 4.0'. This aim was met as several fields of management which are highly affected were identified. An analysis of the literature on the topic was also carried out. The main contribution of this paper can be characterized as a systematic overview of knowledge on the given topic. The paper can serve for further research, either in the theoretical area, or it can be used as one of the basic theoretical starting points for further empirical research.

First, process management is highly affected. Digitalization is especially process question and high-quality processes, and their arrangement is currently at the forefront of managerial interest. Question of digital process maturity (or process maturity as well) is also a very important topic. Second, change management is important field because new changes need to be implemented all the time. This field of management is connected to everything in company, from organizational structure, through corporate culture and strategy, to human resources management and innovation management. These are main reason for being interested about the topic of Industry 4.0 and change management as main instrument for its implementation.

Enormous changes in fields of process management, human resources management, change management and talent managements are being expected. Last, but not least it is relevant to discuss topics like business model, value chain, new skills demanded or project management field.

It is obvious that connection on Industry 4.0 and change management or process management is becoming more important. More and more research is being done on this topic and the issue of implementing new technologies is crucial for business managers.

Sustainability pressures can be expected to intensify in the future. It is also worth mentioning that especially the field of human resources management and digitization has been significantly accelerated by the Covid-19 pandemic.

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Conflict of interest: none.

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The Relationship Between Social Media and Small and Medium-Sized Enterprises

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Abstract: Social media has become extremely attractive to the business sector thanks to its range of possibilities. We examine what kind of thinking scheme the SME sector conducting economic activity in Hungary and Slovakia have regarding the field of social media. In the first part of our study, we examined the conceptual definition of social media and its role today, placing great emphasis on the overview of its potential from the company's point of view. The secondary data collection was carried out with the help of extensive literature processing. After that, we provide insight into the identification of the primary goals of the research, as well as an overview of the methodological processes of the research. The results obtained during the investigation process are presented in the second part of the study. With the help of a questionnaire, 1,114 companies operating in Hungary and Slovakia are being investigated. The research results revealed that the social media-related activities of small and medium-sized enterprises conducting economic activity in Hungary and Slovakia are slightly moving in the right direction, however, unfortunately, an extremely large number of enterprises are still not aware of the benefits provided by online platforms and their potential.

Keywords: social media; SME sector; corporate point of view

JEL Classification: D23; M31; M31

1. Introduction

It is an indisputable fact that information and communication technology has developed at an almost unfathomable speed in recent years and decades. This type of innovation has led individuals and businesses alike to be globally present, resulting in a complete change in the daily life of society and business (Machová et al., 2013). We all depend on the Internet to connect with others and quickly access the information we need. Due to the low costs and minimal technical requirements of social media, it is becoming more and more popular and attractive, as a result of which it becomes indispensable for many businesses. It can also be said that by the 21st century, the use of the Internet, and with it social media, has become an integral part of business strategy. Social media creates a group of consumers who also make their lives easier in terms of finding more detailed information and communicating more easily with businesses that sell products and services. Nowadays, many business people use social media platforms to support their company activities. From the company's point of view, social media can be defined as a means of two-way communication with consumers, in order to ensure that consumer needs are heard. Overall, it can be said that the use of social media has a significant impact on the operation and success of a business (Soelaiman & Ekawati, 2021). Social media

is a dynamically changing tool that requires innovative thinking. In addition to the characteristics of social media, the need for thinking outside of the traditional is triggered by the changed consumer behavior, which shows itself with initiative and the corresponding demand in the corporate relationship system. In social media, the direction of the information flow changes, and the roles are exchanged and become parallel (Bányai, 2016). The primary goal of our research is to show the reader exactly how Hungarian and Slovak small and medium-sized enterprises think about the issue of social media. The reason for choosing small and medium-sized enterprises as research subjects is that the use of social media enables small and medium-sized enterprises to share their opinions and information related to products/services with their partners and customers (Shaffer, 2013). Small and medium-sized enterprises play an extremely important role in modern economies (Bayraktar & Algan, 2019). This sector is usually described as the most powerful innovative system. They are the main catalyst of economic development, and also intensively contribute to the achievement of the basic goals of any national economy, by becoming the backbone of socio-economic development (Neagu, 2016). In order to achieve our goal, in the theoretical part of this study, we review the conceptual definition of social media and its positive effects on companies. After that, the methodological process used during the primary data collection will be presented. Before starting the research process, two hypotheses were formulated, and in order to prove their correctness, the authors conducted a quantitative questionnaire survey in Hungary and Slovakia. A total of 1,114 companies joined the research. The IMB SPSS Statistics 25 program was used to perform the statistical data analysis. At the end of the research, it can be stated that the hypotheses formulated by the authors proved to be correct, based on which it can be stated that it can be stated that the time of the company's presence on the market is not significantly related to the importance of presence in social media in the case of any country. Furthermore, it can also be established in relation to both countries that there is a significant correlation between the proportion of the company's marketing costs spent on social media and the expansion of social media exposure.

2. The Potential of Social Media from a Corporate Perspective

Many researchers have dealt with the definition of social media and are still dealing with it to this day. According to Kaplan and Haenlein (2010), social media can be defined as a group of Internet-based applications that are based on Web 2.0 technologies, enabling the creation and sharing of user-generated content with others. Social media includes content distributed through interactions between individuals and organizations (Kietzman et al., 2011). One year later, Larson and Watson (2011) defined social media as a set of connected applications that help facilitate interaction and the creation, sharing, and exchange of information between businesses and consumers. According to Strauss and Frost (2010), social media can be defined as a group of tools and platforms that allow people using the Internet to interact with each other by providing opportunities to share their experiences. In addition, users can also connect to individual platforms for business or entertainment purposes. Overall, it can be stated that social media is an online platform that companies primarily use to share content, thoughts, and experiences with their own target audience that serve as

useful information for consumers. Marketing on social media platforms is an essential trend for businesses to easily reach their target audience. This type of marketing involves the use of social media platforms to promote a product/service. In fact, social media marketing can be defined as a subset of online marketing activities, as they play an important role in addition to web-based promotion strategies. By encouraging users to share their messages with companies, this type of marketing has put the term trust in a new perspective in mass communication. When we talk about social media, it goes without saying that there are many different social media sites that take many forms and perform different functions. It is an indisputable fact that the most common social media site that comes to mind first is none other than Facebook. But we can't leave Instagram, Tik-Tok, Twitter and LinkedIn without saying a word either. These types of websites have completely changed the way businesses think about advertising. There are businesses that direct their customers directly to their social media pages instead of their own website (Arsath, 2018). In his study, Nugraha et al. (2012) presented the application of social media in cloud computing. In his opinion, the use of this reduces the costs of the IT investment. In his 2014 research, Van Wyk (2014) drew attention to the benefits of social media in supporting educational endeavors. In 2015, Mittal (2015) and his colleague defined six factors that can be characterized as advantages of social media. These factors are summarized in Table 1.

Table 1. Benefits of social media (Mittal, 2015)

	Benefits of social media
1	It facilitates open communication, which leads to better information discovery and transmission.
2	It allows employees to discuss ideas, post news, ask questions and share links.
3	It gives you the opportunity to expand business relationships.
4	It targets a wide audience, making social media an effective recruiting tool.
5	Improve your business reputation and increase your customer base with minimal advertising.
6	It expands market research, implements marketing campaigns, communicates and directs interested parties to specific websites.

Sajid (2016) stated that social media has advantages that are essential for businesses. These benefits include cost reduction as well as increasing the likelihood of revenue generation. According to the authors, social media also enables companies to share knowledge and information. During their research, Drahošová and Balco (2017) came to the conclusion that the two biggest advantages of social media are information exchange and communication, and data sharing. According to Arsath (2018), the primary benefits of corporate marketing on social media are cost-effectiveness and quick and effective reach of the target audience. The cost of presence on online platforms is lower than the use of other traditional marketing tools, and this type of marketing activity allows companies to reach consumers who otherwise would not be available to them due to time and location constraints. In addition to these factors, Arsath (2018) mentions interactivity, the possibility of a targeted market, and customer service among the main advantages of social media. The interactivity of this new type of media allows consumers to become more than passive receivers of information. This type of user interactivity allows consumers to engage in two-way communication with businesses. Reflecting on the target market, social media allows

businesses to target their marketing activities to the most suitable target audience for them. Finally, it is important to mention the customer service. At times, website designers are unable to avoid the complexity of website construction, resulting in the need for a proper customer service system and social media provides an excellent opportunity for this (Arsath, 2018). In 2019, Munir and his colleagues came to the conclusion that social media has some advantages. The first factor is personal branding, followed by social media marketing, which is extremely popular these days and can result in extremely good results for businesses. The third factor is the possibility of close interaction with consumers, since the online space provides an opportunity for two-way communication. Through the platforms, marketers have the opportunity to learn about the consumer needs and habits of the target audience. And the last factor is the "viral" rapid spread of information (Munir et al., 2019). In 2019, Venkateswaran and his colleagues also investigated the potential of social media. The authors came to the conclusion that 12 advantages of the online space can be defined from a corporate point of view. The authors highlighted the following benefits: knowing and effectively reaching the target audience, cost-effectiveness, immediate feedback, personalized communication, creating a corporate identity, improving market intelligence, accelerating innovation, increasing visibility on the Internet, facilitating recruitment and recruitment, easier and faster communication and building trust and loyalty (Venkateswaran et al., 2019). In conclusion, it is vital that businesses seize the opportunity and take full advantage of all new and innovative technologies, including social media platforms. (Bakri, 2017).

3. Methodology

In the practical part of our study, we conducted a questionnaire survey in Hungary and Slovakia. The subjects of the study were enterprises that, considering their characteristics, belong to the group of small and medium-sized enterprises. Our primary goal with the research was to get a comprehensive picture of the examined research area in both Hungary and Slovakia. The research process began in Hungary, where the authors conducted an investigation among small and medium-sized enterprises in 2020. After that, 1 year later, in 2021, the authors repeated the research for Slovakia in the Slovak SME sector. Quantitative research is usually deductive in nature, which also applies to research conducted by authors (Boncz, 2015). This type of approach is primarily used to test theories. Related to this, the first step of the research process was an overview of theoretical approaches, followed by the formulation of hypotheses and the development of a research strategy (Saunders et al., 2019). In order to formulate appropriate conclusions, it is necessary to test the hypotheses, which can be implemented using different statistical methods (Boncz, 2015). Before starting the investigation process, two hypotheses were formulated, which are the following:

- The longer the company has been on the market, the more important it is to have a presence on social media.
- The larger the percentage of a company's marketing spend on social media, the more likely it is to plan to expand its social media presence.

The questionnaire used during the inquiry included four main parts, which are as follows: the presentation of the most important information regarding the purpose of the research, general and introductory questions regarding the subjects of the research, the main questions regarding the research area, and the acknowledgment (Hunkár, 2013). In terms of its nature, our research can be defined as a once-repeated investigation, since the survey was conducted in two installments, in 2020 in Hungary and in 2021 in Slovakia. Our choice of small and medium-sized enterprises can be justified by the fact that, thanks to their innovativeness, this group of companies plays an indispensable role in the economy of a country. Following the previously mentioned structure, the questionnaire sent to the enterprises contained twenty-seven closed questions, for which the surveyed enterprises could only select one answer option. The authors prepared the questionnaire with the help of the Survio questionnaire creation program, and for the enterprises, they used a database compiled by themselves and distributed it to small and medium-sized enterprises by e-mail. Approximately 23,000 questionnaires were sent out, of which 1,114 responses were received from businesses. After receiving the answers, the authors evaluated the data in the first two steps and then used the IMB SPSS Statistics 25 program to check whether the formulated hypotheses hold up in reality for both countries. In order to be able to do this, we performed a Chi-square test with the help of statistical software, for which we determined a significance level of five percent. Considering the two formulated hypotheses, it can be said that the variable found in each hypothesis is nominal, as a result of which it is possible to perform the Chi-square test. The output of the nominal scale classifies quality properties (Sajtos & Mitev, 2007). The following formula can be used to calculate the Chi-square test:

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i} \tag{1}$$

In the formula, *O* is the observed frequency and I is the expected frequency (Singhal & Rana, 2015).

4. Results

At the end of the inquiry process, it can be established that 53% of the responses received came from Hungary and 47% from Slovakia. Taking the small and medium-sized enterprise sector into account, the distribution was as follows: in the case of Hungary and Slovakia, the majority of responses came from micro-enterprises. They were followed by small businesses, then medium-sized businesses, and the results also clearly show that in the case of both countries, most businesses have been present on the market for more than 10 years. After the demographic questions, the authors moved on to questions related to the research topic. Considering the 591 Hungarian businesses, it can be said that 451 of them answered that they are present on social media, and Facebook is considered the most popular social platform in the country. This value was formed in Slovakia in such a way that 402 of the 523 companies surveyed answered that they are present in the online space and, like in Hungary, the most important platform for them is Facebook. The authors also considered it important for what

reason individual businesses use social media. In Hungary, it is the most important for most businesses because of the increase in income, and in Slovakia, most people said that social media is indispensable for them because of the provision of information. In the questionnaire, we were also interested in the extent to which it is important for organizations to be present on social media on a Likert scale of one to five. During the evaluation of the answers, we compared the average answers. We came to the conclusion that the businesses of the two countries think similarly, since the average answer in both countries is that it is of above-average importance to them. Considering that businesses are not the only ones present on the market, we also discussed whether they observe the activities of other businesses on social media. For both countries, the majority of businesses (more than 60%) observe how the competing company manages its own social media platform. However, in addition to the competitors, we also considered it essential to ask whether they monitor their own target audience in the online space, placing great emphasis on how and in what direction people's consumer needs change over time. In this case, we obtained similar results in relation to the previous question, since most businesses stated that they monitor their consumers. At the end of the survey, the authors also focused on questions about the future. Based on the results, it can be stated that Hungarian businesses think differently compared to Slovakian organizations, because in Hungary, several of the interviewed businesses think that their goal for the future is to be present on even more social media platforms. The way of thinking of Slovak businesses is different, as less than half of the surveyed businesses plan to appear on several social media platforms. It is surprising, however, that nearly 60% of those who want to expand their presence in social media in Hungary plan to invest more capital in the online space, but in the case of Slovak businesses, we found that less than 50% – would they be willing to do so, or do the two countries have different ways of thinking.

4.1. Hypothesis Analysis

In this study, the authors formulated two hypotheses related to the corporate social media research topic. In the case of the first hypothesis, the authors assumed a relationship between the fact that the longer the company has been present on the market, the more important its presence in social media is. In order to verify the correctness of the hypothesis, the authors performed a Chi-square test using the SPSS statistical program. The reason for choosing the statistical analysis lies in the fact that in the present case it is an ordinal or a nominal variable. Table 2 illustrates for the reader the results obtained after the analysis.

The Cramer V indicator related to the first hypothesis can be clearly read from the table that 451 responses to this question were received in Hungary, while 402 were received from Slovakia. Furthermore, the results show that the first hypothesis does not hold true for any of the countries, that is, it is not valid, since the value of the Asymptotic significance (2-sided) is higher than the specified five percent significance level.

In the case of the second hypothesis, the authors assumed a relationship between the larger percentage of the company's marketing costs that the social media presence accounts for, the more likely it is to plan to expand the social media presence. The third table summarizes the results related to the second hypothesis for the reader.

Table 2. The Chi-square test related to the first hypothesis

Hungary			
	Value	df	Asymptotic Significance (2-sided)
Pearsons Chi-Square	12.026	12	0.444
Likelihood Ratio	13.589	12	0.328
N of Valid Cases	451		
Slovakia			
	Value	df	Asymptotic Significance (2-sided)
Pearsons Chi-Square	10.534	12	0.374
Likelihood Ratio	11.725	12	0.218
N of Valid Cases	402		

Table 3. The Chi-square test related to the second hypothesis

Hungary			
	Value	df	Asymptotic Significance (2-sided)
Pearsons Chi-Square	993.787	15	0.000
Likelihood Ratio	78.799	15	0.000
N of Valid Cases	451		
Slovakia			
	Value	df	Asymptotic Significance (2-sided)
Pearsons Chi-Square	864.512	15	0.000
Likelihood Ratio	68.497	15	0.000
N of Valid Cases	402		

The results allow us to conclude that there is a significant relationship in the case of both Hungary and Slovakia, since in this case too we obtained smaller results than the 5% significance level. Similar to the first hypothesis, in this case as well, we examined the strength of the relationship between the two variables. The results are illustrated in the fourth table.

Table 4. The Cramer V indicator related to the first hypothesis

Hungary			
		Value	Approximate Significance
Nominal by Nominal	Cramer's V	0.748	0.001
N of Valid Cases		451	
Slovakia			
		Value	Approximate Significance
Nominal by Nominal	Cramer's V	0.652	0.000
N of Valid Cases		402	

Considering the data in the table, it can be stated that in this case, too, we can speak of a medium to stronger relationship in relation to both countries. Taking into account the results obtained during the hypothesis analysis, the conclusions and proposals related to the analysis are presented in the next chapter of our study.

5. Discussion and Conclusion

In the first, theoretical part of our study, after a short introduction, we examined the most important factors that can be classified as advantages of social media from the company's point of view. After that, the investigation methodology related to the research was presented, taking this into account, it can be said that the authors conducted a quantitative survey among small and medium-sized enterprises in Hungary and Slovakia in the form of a questionnaire, the results of which were evaluated using the SPSS statistical program. From the point of view of the research, the first key question was whether the surveyed businesses are present in the online space. Although in the case of both countries, we obtained the result that yes, they are present, but there are still businesses that do not want to take advantage of this opportunity. In our opinion, the reason for this is that they are not fully aware of the benefits that each online platform offers them. With the theoretical part of our study, our aim was to show businesses how many opportunities there are for them with a presence in social media, which they cannot ignore, especially in today's world, when consumers almost live part of their lives online. We consider it important to draw the attention of businesses to take advantage of this opportunity and enter the online space, and we also recommend that if they decide to do so, as a first step, they should examine where their own target audience is present and place them on that platform(s) great emphasis. As already mentioned in the results chapter, the businesses of the two countries consider social media important for completely different reasons. From a corporate point of view, it is completely natural that the company's primary goal is to increase its revenues, but this should only be a consequence. If a business focuses on consumers, on communicating with them as much as possible, getting to know their consumer needs, and providing information about their products/services, over time this will also attract an increase in income. In any case, this should be a long-term goal and businesses should realize that being on social media will not immediately generate revenue for them. However, with time and proper care, they can achieve this. We consider it important to draw their attention to this, because the businesses of both countries stated that their presence in the online space is of above average importance to them. As we mentioned earlier, social media is also crucial for businesses from the point of view of being able to monitor both their own target audience and their competitors. The latter is also of particular importance, since the given company can already incorporate the criticisms of competing companies (whether it is about products or services) into its own operating process, i.e. it can learn from these criticisms ahead of time, which saves a lot of time and energy. the organization. Social media helps them stay up-to-date, whether it's their customers or their competitors. Regarding the future, we recommend to small and medium-sized enterprises that, in order to remain competitive, it is extremely important to place a great emphasis on being present in the online space, moreover, in such a way that they are present on more and more platforms as time progresses, because if you think about it, nowadays there is little chance that a consumer is present on only one platform. For the sake of greater visibility, businesses should be present on as many platforms as possible where their consumers are also present. However, if businesses decide this way, it is extremely important that they do

not regret investing more capital in their online presence. The way to implement this in practice is to involve external persons, or to employ a special person who will be specifically responsible for the presence on social media. The research results should also be expanded with the results of the two hypotheses defined by the authors. In the first hypothesis, we assumed that there is a relationship between the time of the company's presence on the market and the importance of presence in social media. In this case, we came to the conclusion that the two variables are not related to each other. This leads us to conclude that the presence in social media is not only the most important thing for medium-sized businesses, in fact, if you think about it more, the smaller a business is, the more important it is for them to be online, as it is a cost-effective solution for them, which is an essential aspect for them. In the case of the second hypothesis, the authors hypothesized a relationship between the fact that the more part of a company's marketing costs is social media presence, the greater the probability that they will expand their social media presence in the future. Based on the results, it can be stated that this hypothesis is valid for both countries, and we can even speak of a closer than average relationship between the variables. This allows us to conclude that those organizations that currently think that online presence and related marketing activities are important to them, and that it is also reflected in marketing costs, then a higher percentage believe that they will expand this presence in the future, i.e. have a positive experience. All in all, it can be said that since the online world, including the area of social media, continues to develop rapidly and defines our everyday life, it is therefore considered a remarkable research area. Regarding the future of research, the authors have several ideas for continuing the investigation. As a first step, our goal is to involve additional businesses in the research process (to carry out investigations in several regions), as well as to involve small and medium-sized enterprises operating in other countries. In other words, the primary goal is to expand the number of research subjects in order to learn more about the way of thinking of small and medium-sized enterprises, as well as to be able to make deeper comparisons. We also aim to repeat this query on an annual basis in order to be able to examine how the way of thinking of businesses changes over time. In addition, for the future, we also consider it important to prepare a survey for consumers in addition to a questionnaire for businesses, as a result of which we will be able to compare the two points of view, which will also reveal whether the surveyed businesses think properly about consumers in connection. With this, our further goal is to create a document for businesses that provides them with answers to think about their consumers properly, as well as summarizes the results obtained during the research and includes suggestions for the future of the business.

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Partnerships between Chemical Companies and Universities

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Abstract: Our current society is globalized, interconnected, and dependent on the collaboration of various entities and institutions. This collaboration and its influence on innovations in the knowledge society is a subject of research, and it reflects in the theory in the basic model depicting partnership in the form of the so-called triple helix model, where the partnership entities are represented by universities, public institutions, and companies. This paper focuses on partnerships between universities and companies from the point of view of the way how this partnership helps all the participants and benefits society. The paper describes the forms of partnerships and the advantages and disadvantages they have for the participants. It includes the outcomes of the research, which was conducted through the analysis of websites, annual reports, and structured interviews with representatives of three university faculties focussing on the area of chemistry and three chemical companies in the Czech Republic. Although the research implies that the partnership brings a number of benefits to both parties, it also identifies diverse views of an optimal form of cooperation on the side of universities and companies.

Keywords: partnership; triple helix; chemical industry; Czech Republic

JEL Classification: I23; O31; L65

1. Introduction

In the current society, there are various partnerships, and they can be described through different models based on their types and number of partners. The basic model defining forms of partnerships was created by Etzkowitz and Leydesdorff in 1995 (Etzkowitz, 2008), and they called it the triple helix model. The triple helix model concept was developed as a response to the emerging knowledge economy in the ’90s of the 20th century (Cai & Lattu, 2022). The authors mainly wanted to explain dynamic interactions among the academic communities, industry, and government. This model was created to support entrepreneurship, economic growth, and innovations in the knowledge-based economy (Etzkowitz & Leydesdorff, 2000). The triple helix model is, according to Cai and Etzkowitz (2020), based on five main aspects – the existence of complex relationships between different players in regional innovations, the mechanism of subject interaction within the triple helix model (the ability to take over the role of the other), evolution in time (the evolution process of the model and its structuring and coordination), convenient interaction within the model (where not only the potential top-down

coordination, but also bottom-up initiative are required), and effects of both tangible and intangible conditions on the model (the most important aspect).

Entities that are willing to work in groups can create bilateral, trilateral, and multilateral cooperative bonds. Such bonds can be created by economic entities in all sectors of the national economy (Tetrevova et al., 2017). However, the term partnership is often misunderstood by the lay public, and that is why it is necessary to define it correctly. Cepelka and Potluka (2011) point out the definition issued by the government of the Czech Republic (CZE) in 2009, which says that partnership refers to a common target and interest, close cooperation, and common responsibility for common projects, mutual support and confidence, mutual consideration of needs, the equal position of partners, higher performance while implementing various projects and their greater transparency. Mutual awareness and exchange of experience are also important.

Cooperation between universities and industry has a long history. Either of these entities is aware of their position in society, and they know that their operations would be limited without the support of the other partner (Tetrevova & Vlckova, 2018). Three basic areas of cooperation include collaboration in the area of research and development (R&D), cooperation within education, and commercialization of R&D results (Skopkova, 2007). Charles and Conway (2021) tried to put forms of cooperation into four categories as follows:

Services based on R&D – the creation of knowledge through sponsoring of scientific projects using research and other technical facilities.

Utilization of the latest existing knowledge – drawing on inspiration and professional expertise from patents, copyrights, or other forms of codified knowledge to be applied in practice.

Human resources exchange connected with exchange programs – exchange of academic workers or university students with the business sector based on the transfer of knowledge from theory to practice and vice versa.

Spin-off companies and other new companies – the creation of programs encouraging graduates to establish new companies with the support of infrastructure in entrepreneurship (incubators, scientific parks).

The form of cooperation based on contract research, founding spin-off companies, and participation in clusters to create a suitable business infrastructure is substantial for both sectors (Hrušová, 2012).

Contract research represents the implementation of activities that have the character of research, development, and innovations as a service for reward provided to a third party. It is R&D to the order of a company which the university fulfills for a fee. These projects are original, and they mostly serve the needs of the organization financing the research, and they use the know-how and potentially top research equipment on the side of universities. A spin-off company is a company that uses tangible or intangible assets of another legal entity to start its own business activities (Komarek, 2006). A spin-off company is established to develop new knowledge, which is its intellectual property, and it has a lot of forms (Tormo-Carbo et al., 2014; Miranda et al., 2018). Dostalova and Drabkova (2020) state that the establishment of such a company is a much more complex process than the form of technology licensing or

sale. According to the type of involvement of the research organization in the spin-off company, there are three types of companies in the Czech Republic – a company with 100% equity participation of the research organization, a spin-off company with a share of a research institution, and a spin-off company without a research organization (Smolka & Bold, 2020). A cluster represents a beneficial partnership of companies, universities, and regional institutions, which has a lot of benefits for all its members (Paytas et al., 2004). Thanks to its structure, it can respond to new ideas and innovations and thus support research bases. Clusters can be horizontal (comprising manufacturers or suppliers of the same orientation with a minor deviation; the reasons are better prices of materials, raw materials, or services, better sales opportunities, or international cooperation), vertical (arising by the interconnection of subcontracting companies and institutions doing business in the same area, but with a different professional orientation, into a strategic chain; companies can operate as a whole, which can reflect in the prices of the provided services or the volume of orders), and lateral or side (a manufacturer creates a strategic interconnection with potential processors) (Panchártková, 2017).

Triple helix model entities formally cover partnerships through a partnership agreement. It specifies the reason for which the partnership has been established, if it is time limited, and it can also define the target of this partnership. A company can establish contact with a university directly or through mediators. In the Czech Republic, such mediators for building partnerships in the chemical industry include the Association of Chemical Industry, the European Association of Chemical Industry, the Czech Chemical Society, and CzechInvest. There are three levels of partnerships – a partner (a company cooperates with a university in the normal range), the main partner (such a partnership brings more significant opportunities for influencing a scientific institution and more demanding forms of cooperation and more intensive interaction), and a general partner (there is usually one only, it has the greatest authority, and it is usually integrated into the university R&D and other activities on a long-term basis, it contributes to the development of the university through its finances and practical know-how).

In the last 15 years, there has been a demonstrable interest in cooperation between universities and industrial companies regardless of its chosen form. Obviously, companies and universities have different opinions concerning the functioning and future development of their partnership. The attitudes of the collaborating parties were the subject of research conducted by Bekkers and Bodas Freitas (2008). The research showed that both companies and universities consider direct cooperation mainly as an effective tool for creating results. Academicians attach more importance to the transfer of information from the academic sphere to business. Most companies admit that without basic R&D it is no longer possible to innovate and that it can be used as a basis for applied research targeted directly at their business plan. The motivation and interests of the collaborating parties were assessed by Pitner and Tovarnak (2011). Their assessment implies that what companies see as of great importance is the licensed use of patented R&D results. On the contrary, they do not see big potential for legally unprotected R&D results, or in doctorands' R&DCompanies show great disinterest in sharing knowledge of their own experts within pedagogical or scientific work

at scientific institutions or the academic sphere due to their high workload. Universities, on the other hand, value it very much.

Companies put a lot of pressure on R&D activities in the area of applied research. It is necessary to combine the usability of R&D outcomes on the global level with usability in the industry (Lacko et al., 2008). It is also essential to improve communication between universities and their long-term strategic partners and between universities and their ex-students or ex-academicians (Lacko et al., 2008). If universities apply for international grants from European programs or national financial means, they are forced to prove the usability of R&D to be financed, and this is where the role of their partners from practice who will participate in R&D and eventually apply the outcomes is indisputable (Lacko et al., 2008).

Partnership support is financed not only by the state through national sources, but university-company partnerships are also supported by the European Union (EU) for the reason of knowledge and research development. Drawing European funds, which finance cooperation between companies and academic or scientific institutions, helped the state, as one of the triple helix model entities, reduce a significant part of the financial burden. Subsidy programs operate in yearly and multi-year periods. As for the EU, they are seven-year programming periods.

Together with the member state authorities, the EU supports various types of financing partnership projects. The main types of financing include grants, financial tools (loans, securities, and equity), subsidies, trust funds, or pricing. For example, the subsidy program of Horizont Evropa now takes place in the form of a grant. This program is mainly focused on the development of innovations and investments, education, science, and research. In connection with it, the subsidy fund of the educational program of Erasmus+ has also been doubled for the reason of the development of talented people (Gafrikova, 2021). The main subsidy program pillars include investments in scientific R&D, innovations, cooperation with the industry, transfer of the research outcomes into practice, and commercialization.

These activities are also supported on the national level. For instance, the Czech Republic is willing to support the development of innovations, knowledge, and skills. The country supports the business and academic spheres through its own institutions, such as the Czech Science Foundation (Grantova agentura CR) for basic research and the Technology Agency of the Czech Republic (Technologicka agentura CR) focusing on the support of research applicable in practice.

2. Methodology

The research was based on the primary analysis of secondary sources dealing with triple helix, quadruple helix, and quintuple helix. By narrowing the research to the partnership of universities and companies and by choosing the industry – the chemical industry in the Czech Republic, it was possible to determine the research target. The research aimed to specify what forms the partnerships between universities and companies in this particular area take, on what principles and how intensively the cooperation runs, how it is implemented, and what the partnership brings to both parties.

To fulfill this target, comparative analysis and structured interviews were chosen as the qualitative research methods, and partnerships of three universities focusing on education in the area of chemistry and three selected chemical companies in the Czech Republic that cooperate with universities on a long-term basis were analyzed. The data were collected by authors´team using a content analysis of websites (from June 2022) and annual reports (year 2021) of the universities and companies. At the same time, structured interviews were conducted with representatives of the assessed institutions (at the universities vicedean, specialist officers of the faculty resp. the university and personal managers of chemical companies has been interviewed). The structured interviews have been focused on areas of questions: identification of university/company, forms of the partnership and its usage in practise, assessment of the partnership and financial support of the partnership.

3. Results

The research respondents included three public universities in the Czech Republic focusing on the area of chemistry (University of Chemical Technology Prague, the University of Pardubice – Faculty of Chemical Technology, and Brno University of Technology – Faculty of Chemistry – hereinafter referred to as VSCHT, FCHT UPCE, and FCH VUT) and three chemical companies (ORLEN Unipetrol, a.s., Synthesia, a.s., and ASIOgroup).

For a summary of the basic characteristics and forms of partnership at universities and faculties focusing on education in the area of chemistry, see Table 1 below. All the universities and faculties are involved in various forms of partnership with companies, and each of them has defined a strategy they apply in this area.

VSCHT now has four faculties focusing on chemistry, and so it is the largest assessed university, not just a faculty, which gives it a specific position. As for the forms of partnership, this university mostly uses contract research. Within such research, they solve projects focused on solving analytical and technological issues from the practice of entrepreneurial entities, and sometimes it is also service work (custom analysis). In 2014, VSCHT established the Technology Transfer Department, which provides the university with counseling in the area of protection of intellectual property, and it also helps with founding spin-off companies. These firms mostly operate on the principle of granting a license and establishing a new company with the legal form of a limited liability company (s.r.o.). VSCHT is also involved in the cluster CZECHIMPLANT z.s. It is a cluster with a horizontal arrangement. VSCHT shows great interest in cooperation with the industrial sector. It usually prefers direct cooperation, but it is not opposed to cooperation through intermediaries. The university also uses the possibility of sharing experts from practice, which operates based on personal ties and contacts of the academic staff and industry experts.

The university enters into partnership contracts in a lot of areas (research, pedagogical), it has a clearly defined structure of general, major, and other partners. VSCHT Prague has, as for building partnerships, a clearly defined strategy, and it determines the form and the rules for establishing a partnership with the fact that it divides the partners into three categories – a general partner, major partners, and partners. By this division of partnership, the university is, compared to the other ones included in the research, exceptional. In 2015, its partnership

Table 1. Assessment of partnerships at universities

		VSCHT	FCHT UPCE	FCH VUT
Provided types of courses				
	Full-time	yes	yes	yes
	Distance	yes	no	no
	Combined	no	yes	yes
Cooperation within the quintuple helix model		yes	yes	yes
Number of students		3,836	1,322	1,031
Number of employees (calculated number)		1,263.4	324.9	175.53
Forms of partnership				
	Contract research	yes	yes	yes
	Spin-off firms	yes	yes	no
	Official clusters	yes	yes	no
	Unofficial clusters	yes	yes	yes
Cooperation with industry		yes	yes	yes
Sharing experts		yes	yes	yes
Making partnership contracts		yes	yes	yes
Areas of partnership				
	Scientific and research	most often	most often	often
	Pedagogical	often	often	most often
	Other activities	less often	less often	less often
No. of partners from the industry for 2021		N/A	128	131
Use of support from				
	European sources	yes-just as often	yes-often	yes-often
	National sources	yes-just as often	yes- most often	yes- most often
Use of EU fund sources				
	Grants	yes	yes	yes
	Financial tools	no	no	no
	Trust funds	no	no	no
	Subsidies	yes	yes	no
	Pricing	no	no	no
Involvement in the Horizont Evropa program		yes	yes	yes
Support of the Erasmus+ educational program		yes	yes	yes
No. of Erasmus+ students in 2021		91	14	24
Use of European and national sources to support partnerships		yes	yes	yes

with ORLEN Unipetrol, a.s., which is its general partner, resulted in the establishment of the University Centre at the manufacturing plant Litvinov, thanks to which training takes place directly in production.

The university tries to establish spin-off companies. Although it has already established 3 spin-off companies, it runs into ambiguities in what forms of joint ventures they should include in spin-off companies and which not, as some of the companies the university has established do not correspond to theoretical definitions. According to a university representative, it would be suitable to refine, or extend, the definition of the forms of partnerships for establishing spin-off companies. The VSCHT representative also

emphasized that for a seamless partnership it is essential that the utilization of R&D outcomes is sufficiently legally treated for the protection of both parties.

FCHT UPCE cooperates with all the quintuple helix model entities, but mostly with companies. As for the basic partnership areas, it mainly uses contract research. In 2022, it established the first spin-off company for the next commercialization of the important discovery of the pancreatic cancer diagnosis method using lipid analysis made by the team of prof. Ing. Holcapek, Ph.D. FCHT is fully open to the establishment of the next spin-off companies, but it primarily patents its own important R&D outcomes, or it offers their utilization in the form of licenses. In this area, FCHT also uses the support of the university Technology and Knowledge Transfer Centre, and it is involved in the cluster of Nanomedic. It is a vertical cluster. FCHT is interested in extending cooperation with the industrial sector. The association of the Chemical Industry of the Czech Republic is its important intermediary, with whom FCHT has made a partnership contract, and together they, for example, share the organization of the event of the Young Chemist (Mlady Chemik). FCHT shows a great interest in sharing experts from practice. Lectures led by experts from practice are common here, and they are integrated into training as a tool for transferring current information from various areas. Companies can suggest topics for final theses to be solved at the faculty. FCHT uses experts from practice not only for teaching, but also for the assessment of final theses.

As for cooperation with companies, FCHT tries to maintain regular contact with company representatives. Although it supports all forms of partnership, it has not structured its partners into groups. In its contract research, FCHT relies on the interest in the specialized workplaces of the faculty and the continuation of cooperation based on previous experience when establishing this cooperation. What is also positive is its involvement in clusters and the establishment of the first spin-off company. Also here, we can see an effort to support cooperation in the form of utilization of licenses or patents, and protection of these outcomes stabilizes step by step, and we can see an effort to promote more towards potential partners.

FCH VUT is involved in all the basic partnership forms. It mostly uses the form of contract research, where it achieves good results. Although the faculty is inclined to the possibility of establishing a spin-off company, it has not implemented this form of partnership yet. However, it has been involved in one of the cluster projects, i.e. in the pharmaceutical cluster Nanomedic. The faculty is interested in cooperation with industrial partners and communicates with them directly, rather than through intermediaries. The faculty also uses sharing experts from practice, it enters into partnership contracts, which usually relate to the pedagogical area. To a lesser extent, they relate to the scientific-research area.

An important part of the strategy of FCH VUT Brno is maintaining personal ties and contacts with its graduates. This faculty, mainly thanks to these ties, has established cooperation with the largest number of industrial companies from all the assessed universities. As the only one of the universities, it uses the possibility of supervising university theses by external supervisors from practice based on a contract, by which it tries to ensure greater commitment on the part of the company and involvement of students in solving particular practical problems. On the other hand, as for the involvement in clusters

and establishment of spin-off companies, the faculty still has no experience with this form of cooperation or a partner structuring system.

As well as the universities, the researched companies also use various forms of partnership with the academic sphere. Table 2 summarizes the results of the survey conducted at the selected companies.

Table 2. Assessment of partnerships at selected chemical companies

		ORLEN Unipetrol a.s.	Synthesia a.s.	ASIOgroup
Type of company		large	large	medium
Legal form of business		joint-stock co.	joint-stock co.	Ltd.
Type of company by character of activity		manufacturing	manufacturing	manufacturing
Cooperation within the quintuple helix model		yes	yes	yes
Number of employees		4,875	1,500	215
Forms of partnership				
	Contract research	yes	no	yes
	Spin-off firms	no	no	no
	Official clusters	no	no	yes
	Unofficial clusters	yes	yes	yes
Cooperation with universities		yes	yes	yes
No. of cooperating universities with a contract		3	1	1
Sharing experts		yes	yes	yes
Making partnership contracts		yes	yes	yes
Preferred field of education		chemistry	chemistry	chemistry
Preferred level university degree		master's degree	master's degree	master's degree
Areas of partnership				
	Scientific and research	most often	less often	often
	Pedagogical	less often	most often	most often
	Other activities	often	often	less often
Use of support from				
	European sources	yes- less often	no	yes- less often
	National sources	yes- most often	no	yes- most often
Use of EU fund sources				
	Grants	yes	no	no
	Financial tools	no	no	no
	Trust funds	no	no	no
	Subsidies	no	no	yes
	Pricing	no	no	no
Involvement in the Horizont Evropa program		yes	no	yes
Use of European and national sources to support partnerships		yes	no	yes

ORLEN Unipetrol, a.s. is a group of chemical companies manufacturing petrochemical and refinery products. The assessment of its partnership with universities showed that the company only implements one of its forms, i.e. contract research. In the future, new forms are not opposed if it benefits the company. The company has not established a spin-off company, but it nowadays supports the establishment of start-ups both financially and administratively. It is not involved in any of the official clusters either. The company usually cooperates with universities directly, i.e. without intermediaries, focusing on processing final

theses, it employs graduates, helps universities with tuition, and takes part in various events taking place at universities. ORLEN Unipetrol, a.s. is satisfied with the existing form of cooperation with universities, and it wants to continue and develop it. It is the general partner of VSCHT, and this form of cooperation has resulted in the establishment of a training center and the Technology Park at the company premises. The company also cooperates with other universities. A number of students solve actual company problems in their final theses, and subsequently, they become company employees.

Synthesia, a.s. produces qualified chemistry. In the past, the company used contract research, but currently it does not use any of this type of partnership. It has not established any spin-off companies. Synthesia, a.s. and holding Agrofert, a.s., in which is Synthesia, a.s. the member, they have great interest in cooperation with universities. This cooperation takes place directly, i.e. without intermediaries. The company most often cooperates with FCHT UPCE. In 2022, negotiations are underway to conclude cooperation in the areas of student support after the pandemic and the acquisition of new employees for the company. Experts from practice are shared less often. The company has only entered into one partnership contract, which is with FCHT UPCE, and it concerns above all writing final theses. The company also cooperates with Czech Technical University in Prague and VSCHT, but not based on partnership contracts.

Two companies belonging to ASIOgroup deal with the development of new technologies in the area of wastewater cleaning, water treatment, and air purification. The company uses two forms of partnership. The first one is contract research, where it cooperates on the level of examinations and R&D, which serve for verification and development of the company's business plan. It has not established a spin-off company, but it is involved in a cluster called the Association for Water of the Czech Republic. It includes more companies doing business in water management, but there are no universities. ASIOgroup companies are involved in a lot of "unofficial clusters", where companies help each other break into foreign markets and where they share their information. The company has long-term experience with partnerships with universities, and such cooperation takes place directly and is based on personal contacts. Company experts lecture at a lot of universities in the Czech Republic. Students implement their final theses at the company, and they also often find jobs there. The company is open to partnerships with universities. For the time being, it has officially entered into a partnership contract with VUT.

4. Discussion

Due to the long history of the investigated entities, the basic presumption was that each of the companies uses a form of partnership. The above research outcomes can inspire both universities and companies in, for example, VUT FCH and their intensive cooperation with graduates in practice, use of external trainers in final theses, and integration of experts to the boards of study fields. What is inspirational in VSCHT is its active role in the establishment of various forms of spin-off companies, its approach to a partnership as an appraised value it offers to its partners, structuring partners according to the scope of cooperation, and not underestimating the legal security of cooperation. What is inspirational in FCHT UPCE is its

support of the promotion of specialized workplaces, striving for an individual approach, or organizing round tables to assess cooperation and to get more stimuli. In the same way, the approach of businesses can inspire many others, e.g. by combining partnerships with more universities with the most suitable orientation according to the industry orientation of the company, by actively trying to work at the school as part of teaching, or by getting involved in the promotion together with a university as early as within the introduction of the university to secondary schools.

What is also inspirational is the findings about the existence of the so-called "informal" cluster of faculties of chemical technology, which includes VSCHT Prague and all faculties of chemistry from the Czech Republic. This cluster has already existed for 20 years. It serves to discuss current issues of chemical faculties, and it solves the problems of financing and budgeting. It also pays attention to the assessment of research organizations and evaluation of targeted R&D and innovation support programs under the M17+ Methodology (the Office of the Government of the Czech Republic, 2022). Similarly, companies also create informal partnerships within their holding groups and according to the thematic focus.

The research also discovered certain problematic areas in partnerships between companies and universities. Particularly, it is a slow response of universities to the development of the demand for graduates on the market from the point of view of companies, and generally a lower ability to respond flexibly to the situation on the market or the partners' requirements. There is e.i. slow ability to include in studying programs uptodate ICT qualifications required by companies. This response concerns the accreditation of branches, which are however limited not only by the internal rules of universities, but also by the higher education law. This opinion is also reflected in the companies' assessment of the possibilities of educating their employees through universities. They only use them to a limited extent in the case of very specific knowledge. Otherwise, they are more likely to use a commercial offer due to greater flexibility. Companies and universities also differ slightly in their opinion on the qualifications of graduates with respect to the achieved degree, where companies mainly prefer master's degree graduates. On the other hand, universities prefer the equal application of all graduates. An example of more flexible form of preparing of students based on requirements of companies is concept of industry PhD studying program (Roolaht, 2015) used on technical universities in west Europe and USA, but also in some countries of east Europe like Estonia.

The answers from only three companies as selected partners of chemical oriented universities or faculties limit the results of the article, the evaluation of other companies, partners, comparison with partnership of chemical universities and companies from abroad could bring inspiration and it is the plan for future research in area of quintuple helix.

5. Conclusions

Although the research revealed that cooperation between universities and companies exists and that it is positively evaluated on both sides, the full potential of cooperation forms is not being used. Within the cooperation, companies mainly appreciate the possibility of establishing contact with students, i.e. future potential employees, and the benefits in the area

of applied research. An objective finding was the low rate of involvement of partner entities in cluster initiatives, which is connected with their low viability in the area of the Czech Republic. One of the barriers to greater development of other forms of cooperation the companies mentioned is less flexibility and administrative complexity of formal steps on the part of universities.

There is room for improvement, for example, in increasing the scope of contract research, support of patenting R&D outcomes, commercialization of the outcomes through spin-off companies in expanded form with various forms of involvement of partners, and simplification of formal processes for establishing cooperation. The research shows a low rate of establishment and support of spin-off companies, which mainly have the potential to commercialize the results. It is necessary to pay attention to the reasons why it is so, although it is very likely primarily a lack of risk capital. This limits the possibility of successfully commercializing R&D results as well as achieving mutual financial benefits. An impulse can also be greater activity in patenting, which can be the basis for the creation of spin-off companies (Odei & Novak, 2022).

Information sharing could help more frequent linking of universities and companies into clusters. This research focused on partnerships within one industry and only from selected chemical companies, which brings interesting and detailed information about partnerships in this field, but it is also limiting. Further research would be appropriate to extend to the comparison of multiple partners and their assessment of partnerships with universities, to assess the role of the public sector, the public or non-profit organizations in this partnership with the quintuple helix model, and possibly compare with other sectors of the economy or with the situation abroad. It would be beneficial to extend the research to a more detailed analysis of partnership financing options. It was found that national resources and the EU programs are very important sources of funding for the financing of some assets. This issue will become more important, especially with the reduction of support from the EU for developed countries and also in connection with the development of the economy. The resources to the extent they were before the COVID-19 pandemic and the energy crisis will certainly no longer be available (Vlcek & Kostalova, 2020; Bednarikova & Kostalova, 2022).

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Project Management in European Structural and Investment Funds Financed Projects in the Czech Republic

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Abstract: Support from European structural and investment funds has a large impact and significantly contributes to the reduction of differences between regions within the European Union. In the case of the Czech Republic the European Union helped from 2004 to 2021 to development of the country with amount of 1,700 billion CZK. This support is mainly offered in the form of subsidies by which individual projects have been supported. 164,537 projects have been implemented in the period from 2004 to the end of the year 2021. In such case of large number of projects financed from public resources is appropriate to manage them effectively and finished successfully. International standards of project management recommend the useful methods, tools and procedures leading to higher efficiency and success. The main goal of the article is to evaluate the knowledge and usage of project management international standards in the organizations implementing the projects financed or co-financed from European structural and investment funds. 171 respondents mainly project managers of this type of projects answer in questionnaire survey. They hardly know international project management standards, and if they do know them, they hardly use them in practice, with the exception of the PRINCE2 methodology, in which they have some certified employees.

Keywords: project management; project management standards; European funds; programming period; Czech Republic

JEL Classification: O22

1. Introduction

The Czech Republic (CZ) received significant support for its development thanks to its membership in the European Union (EU). European Structural and Investment Funds (ESIF) are the main financial resource of support of investment and development projects in CZ. The planning and usage of resources on European level is repeatedly prepared in the seven year-long programming periods (PPs). For each PP support objectives are set at the European and, subsequently, also at the national level.

In the short PP 2004–2006, 13,290 projects were implemented with total support CZK 62 billion CZK (MMR CR, 2022a). In the normal seven-year long PP 2007–2013, 78,473 projects were implemented with total support of CZK 613 billion (MMR, ČR, 2022b). In the current, just

finishing PP 2014–2020, 72,774 projects were implemented as of 31st of October 2022 and CZK 541 billion were refunded from ESIF to the CZ (MMR ČR, 2022c; MMR ČR, 2022d).

In total, from 1st of May 2004 to 31st of December 2021 expenditures to the European budget at the national level amounted to CZK 743.3 billion and total revenues to CZK 1,700 billion, CZ, thus the CZ received CZK 961.5 billion from ESIF in this period (MF ČR, 2022).

The support is managed in the form of subsidies and to a lesser extent in the form of financial instruments such as loans, guarantees and capital contributions (Kostalova, 2017; MMR ČR, 2022e), however, despite the efforts of the government, financial instruments are not used much, and subsidies predominate within the framework of support.

The support system is implemented in the form of a collection of proposals for innovations, changes and/or improvements with various evaluation procedures for selecting the most suitable solutions. The selected solutions are then implemented in the form of projects. The issue of project management is very widespread in the private and public sector, especially fields such as construction, development of information and communication technologies, event management, but also the construction of infrastructure financed or co-financed by government have many years of experience in the field of projects and their management. Mainly, the international project management standards are used as methodology of project management. In this area are available three international project management standards, developed by international associations: Project Management Institute (PMI) from USA, International Project Management Association (IPMA), association active mainly in Europe, and Association for Project Management from Great Britain (PRINCE2).

International project management standard PMI puts the most emphasis on project manager education of all methodologies, which is why it also publishes the most standards. In 2022, the seventh version of the standard was submitted, namely PMBOK GUIDE – seventh Edition: A Guide to the Project Management Body of Knowledge (PMI, 2021) and it is a fundamental resource for project management. In addition, PMI has issued the following standards: The Standard for Earned Value Management; The Standard for Risk management in Portfolios, Programs, and projects; The PMI Guide for Business Analysis; The Standard for Program Management – Fourth Edition; The Standard for Organizational Project Management; The Standard for Portfolio management – Fourth Edition.

International Project Management Association IPMA created three standards: IPMA individuals competence Baseline, ICB version 4, The IPMA Project Excellence Baseline for excellence projects and the IPMA Organizational Competence Baseline for organizations (IPMA World, 2022). In the Czech Republic, a national version of the standard was created, the International Project Management Standard according to IPMA ICB v. 4 (IPMA CZ, 2022).

PRINCE2 stands for Project IN Controlled Environments, and it is a process – based method. (PRINCE2, 2022).

The above-mentioned methodologies have essentially the same aim and focus, namely, to make known the benefits of using project management in practice, certification of project managers, publishing project management methodologies, benefits of usage of project management methods and tools (e.g. usage of project management office (PMO) or project management information systems) and educating young project managers.

These organizations are not only dealing with classic project management (so-called waterfall), but also the topic of agile project management is increasingly appearing in them.

These international project management standards and setting of project management procedures are mainly used for managing projects in the private sector, even though the PRINCE2 methodology was primarily developed for the needs of the public sector in Great Britain. These standards and procedures are declared to be usable in all sectors for all types of projects. Projects financed or co-financed from ESIF in public, private or non-profit sector are special type of projects, but their successful implementation is also dependent on quality of project management.

The European Union (EU) is aware of this fact, which is why it has developed its own free, lean methodology – PM² intended for the field of project management in general, but especially for a group of projects financed by ESIF and other European programs of European funds (PM² Alliance, 2022). The EU is trying to develop this issue and increase the availability of know-how and strengthen the importance of project management and skills in this area within projects financed from the European budget (PM² Alliance, 2022).

However, analyzes in this area in the CZ and abroad show that project management of projects financed or co-financed from ESIF does not reach the required quality (Melecky, 2018). Especially in previous PPs, the issue of project management was not prioritized by subsidy providers, although it was generally recommended, but the actual use in practice was insufficient (Gazda et al., 2011; Kostalova et al., 2017; Zurga, 2018). There are some improvement activities like courses of project management focused on ESIF financed projects, studying programs or subjects at universities (Stanickova, 2016), but it is a question, if it is sufficient. Based on the available analysis is possible to state that there are administrative barriers and insufficient support to these type of projects (Drotar & Sipikal, 2019; Kostalova et al., 2015).

2. Methodology

To fulfill the goal of the research – verifying knowledge and usage of project management international standards and usage of project management methods and tools in practice of projects financed or co-financed from ESIFs, a publicly available database of projects in current PP in the Czech Republic was used. From the total number of 78,473 projects implemented so far in the PP 2014–2020 (MMR, CR, 2022c), a basic group of project solvers outside the field of education (kindergartens, elementary schools, secondary schools) and housing stock regeneration, who are not typical project solvers in the sense of project management, and beyond the operation program Technical Assistance, which serves to finance the administration of operation programs. The basic file after this modification had 6,231 projects. From this group, 623 respondents were randomly selected, i.e. 10% of the base group. Contacts for these respondents were found on their websites. Subsequently, they were approached and sent in two waves in an online questionnaire survey. The result was 171 responses from respondents who answered all questions. Partial responses were not included in the evaluation.

There are 82 respondents from “Public sector”, 43 respondents from “Profit sector” and 46 respondents from “Non-public sector” in the input statistical set (see Figure 1).

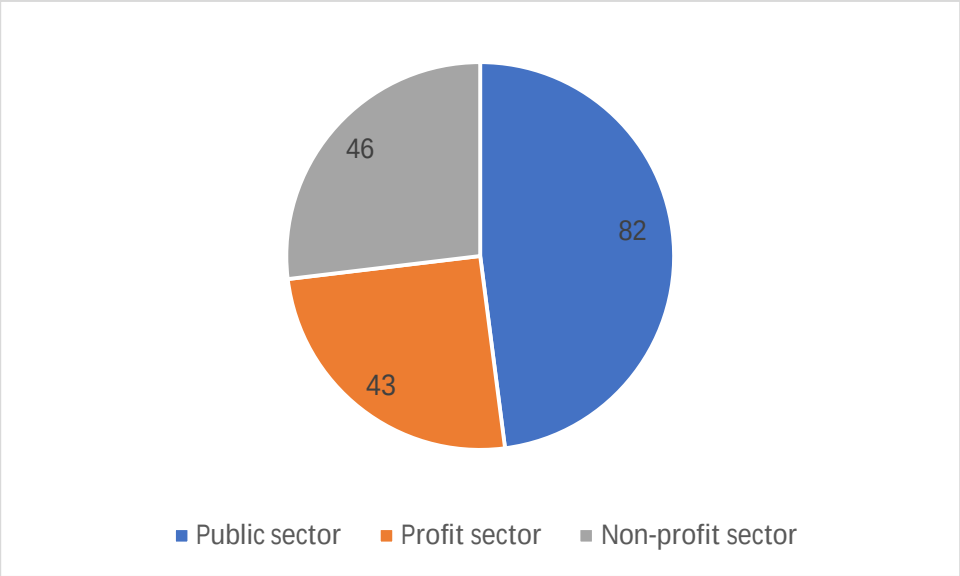

Figure 1: The distribution of the respondents

For analysis or the behavior of the statistical set (input data obtained thanks a questionnaire survey) selected statistical methods from the field of descriptive statistics were used. In particular, it was a clear presentation of the results using frequency tables and graphs.

3. Results

The result in the form of information and knowledge in the area of project management in ESIFs financed or co-financed projects were identified based on the statistical evaluation of inputs data (see questionnaire survey). The results are presented separately in two sub-chapters. Project structure (see sub-chapter 3.1.) and Project management see sub-chapter 3.2.).

3.1. Project Structure

The respondents stated that they mainly implement a smaller number of projects, 94 respondents in the interval 1–10 projects per year, 48 respondents 11–50 projects per year. Those solving a larger number of projects were less represented.

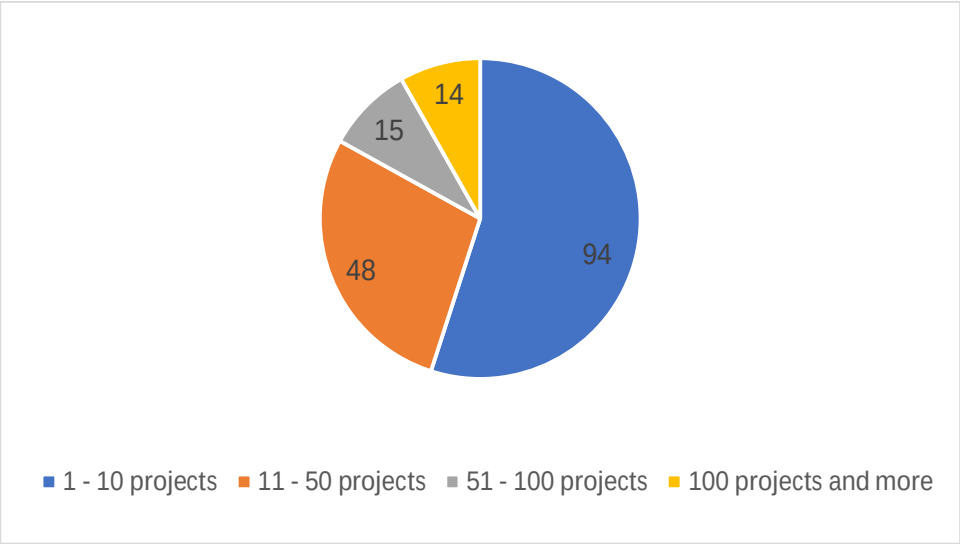

Figure 2: The distribution of the number of projects per year

From this summary, it is possible to draw the conclusion, that most respondents do not deal with a large number of projects, which can lead to a slower pace of gaining experience in this area.

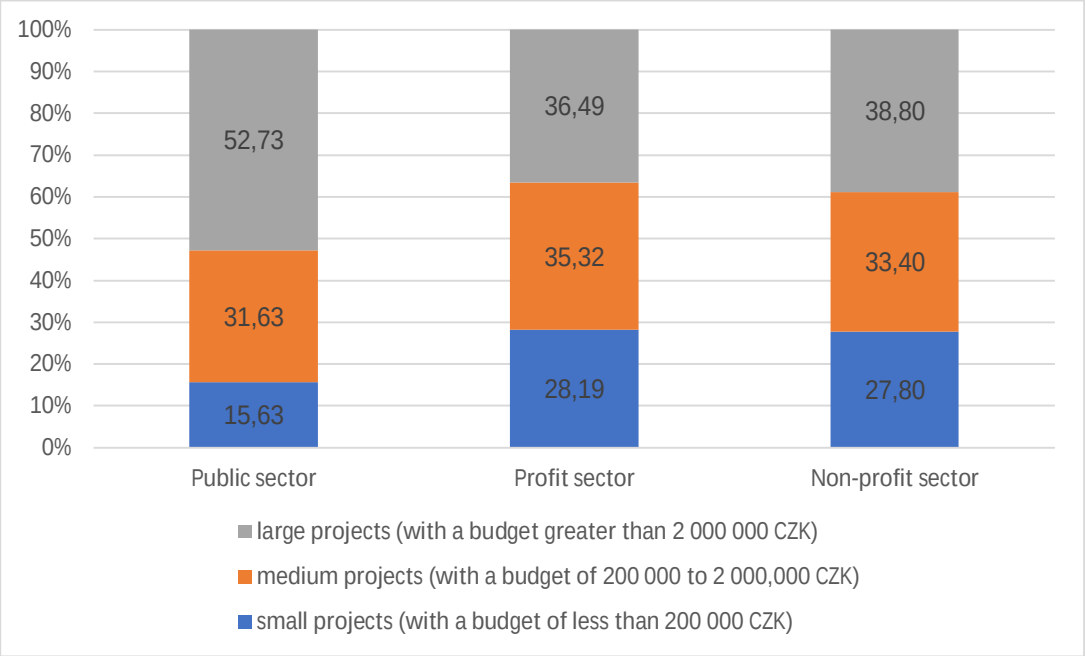

Figure 3: The distribution of the projects according their size

Table 1: The frequency of the projects focusses

	Public sector	Profit sector	Non-profit sector
Investment	61	19	17
Educational	28	10	35
Research and Development	5	22	6
ICT	18	10	2
Infrastructure	38	3	10
Civil engineering	6	4	
Cyber security	3		
Social services	7		18
Reconstruction of cultural monuments	2		
Non-investment	8		6
Culture	2	1	
Environment	2		3
Energetics	2		
Community-led local development			4
Destination management			2
Social life			6
Operational services			2
Employment of target groups			6
Supra-national			2
Innovative		3	
Energy saving technology		3	
Development of social enterprise		1	
Maintenance and repair		1	
Manufacturing		2	
Realization		1	

In the public sector are implemented mainly large projects (see Figure 3), in area of investment, building of infrastructure (see Table 1), in profit and non-profit sectors, the distribution of projects is more even and with a slight predominance of large projects, they are divided into thirds.

In the profit sector, research and development projects, investment projects, educational and implementation of improvement in the area of information and communication technologies (ICT) prevail (see Table 1). In the non-profit sector, mainly projects in the area of education, in the area of social services and investment and infrastructural projects are dealt with.

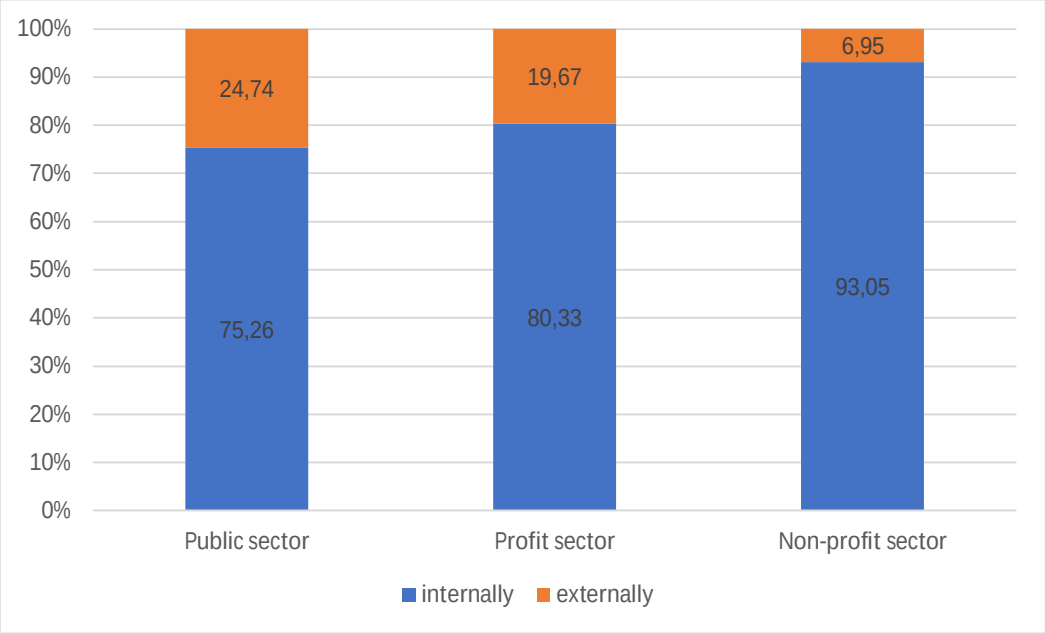

Figure 4: The distribution of the way of projects solving

Project structure is also influenced based on the external or internal project management. Respondents confirmed that the projects are mainly managed by internal project managers and implemented by internal project teams, only 25 % of projects in public sector is managed by external partners. In case of internal project management, the project management maturity and success in project implementation is influenced by knowledge of project management methods and tools and ability to manage the projects effectively.

3.2. Project Management

For evaluation of ability to applicate project management in practice has been selected indicators – existence of PMO, as a center of project management knowledge in the organization and knowledge, usage and certification of project management international standards.

Table 2: The frequency of Project Management Office (PMO) and project management standards

		Total	Public sector	Profit sector	Non-profit sector
PMO	Yes	60	35	12	13
	No	111	47	31	33
Project management standards	Yes	38	17	12	9
	No	133	65	31	37

PMOs are used more in public sector (35 respondents from 82), in contrast to profit and non-profit sectors, where PMOs are used approximately by ¼ respondents. But neither in the public sector do more than 50% of respondents use PMOs. The low level of knowledge of international project management standards confirms the answers of respondents, only 17 (from total 82 respondents) in public, 12 (from total 43 respondents) in private and 9 (from total 46 respondents) in non-profit sectors stated, that they know international project management standards. Furthermore, the answers of only those respondents who stated that they know international project management standards were evaluated.

Table 3: The distribution of the international project management standards

		Total	Public sector	Profit sector	Non-profit sector
PMI	knowledge	25	11	7	7
	practice	3	1	1	1
	certificate	4	1	3	0
IPMA	knowledge	22	9	6	7
	practice	5	2	2	1
	certificate	4	1	2	1
PRINCE2	knowledge	29	14	9	6
	practice	13	5	6	2
	certificate	12	5	4	3
Standard PM² Methodology	knowledge	11	4	4	3
	practice	0	0	0	0
	certificate	0	0	0	0
other				Six Sigma	

Totally, and in the public and private sectors, the best-known international project management standard among respondents is PRINCE2. Only 20 respondents out of a total of 171 respondents have certified managers, and 12 of them have PRINCE2 certification. In the non-profit sector, knowledge of PMI slightly prevails, but it is only minimally used in practice and there is not even anyone with certification in this standard. The implementation of international standards in practice of respondents is also very low – totally only 21 respondents confirm usage of international project management standards in their practice, if they use any methodology, it is primarily PRINCE2.

4. Discussion

Respondents deal primarily with a smaller number of projects, and the fact that they have less experience and knowledge will also be related to this. The project issue is apparently not dominant and it would be desirable to focus more on the project culture. The low level of project approach implementation is also confirmed by the low number of PMOs in practice of respondents. Awareness of international project management standards is very low. Here is a big drawback. Without theoretical background of knowledge, it is difficult to expect that projects will be managed effectively and successfully. It is a pity that the available know-how in practice of implementation of ESIF financed or co-financed projects is not used more. The issue is generally related to the overall management of knowledge at the level of organizations, overall support for the expansion of knowledge improves skills in project management as well (Doskocil & Lacko, 2019; Doskocil & Smolikova, 2012).

The promotion of PM² on the part of the European Union and especially its partner at the national level is very weak – the methodology intended especially for more effective management of projects financed or co-financed from ESIF is almost unknown and unused. This fact cannot be attributed to the project solvers, but rather to the support providers who define and recommend appropriate procedures for project management. On their part, there should be more massive communication on the topic of what procedures to use, that it is possible to reach for international project management standards, especially PM², which is directly intended for this and is available completely free of charge.

The authors of the article are teachers of project management at the faculties of Czech universities and at the same time participate in research projects at their workplaces. Based on their experience, they recommend to focus also on introducing and enforcing the current trend of Agile Project Management (see the 7th versions of PMBOK (PMI, 2021), PRINCE2 AGILE version (Axelos, 2015), Manifesto for Agile Software Development (Beck at al., 2001) and Šochová and Kunce (Šochová & Kunce, 2014)). The agile approach to project design and management responds to the general global trend in projects, where an increasing number of projects finance or co-financed from ESIF fall into the area of research and development projects of technical innovation. This type of project prevails (see Table 1). In these types of projects that prevails also at universities, the use of classic waterfall projects is not very suitable.

5. Conclusions

Among the project managers financed or co-financed from ESIF, there is very little knowledge of international project management standards, these standards are minimally used in practice and only low numbers of project managers or project team members are certified in some of international project management standards. Based on the previous research and confirmation, it is possible to state that the situation during programming periods does not improve much. The limit of the research is the national limitation, the analysis of a random sample. An analysis of the total number of project solvers financed of co-financed form ESIF would have greater reporting power. Further research would be appropriate to focus on deeper research in this area, whether there is at least partial knowledge of basic project management methods and tools and whether they are used in practice. It would also be interesting to compare it with other countries of Central and Eastern Europe, where support from ESIFs is mainly distributed to reduce disparities and inequalities, e.g. in Slovakia, Slovenia, Croatia, Poland and Baltic states. An analysis between administrative workers, creators of methodologies and recommendations, to what extent they are familiar with international project management standards and can thus incorporate them into their methodologies, would also be interesting.

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Financing of Basic Education in the Czech Republic – Macroeconomic Context

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Abstract: In the last few years, there has been a significant increase in expenditure on primary education in the Czech Republic, where they account for about 10% of all government expenditures. The aim of this paper is to analyze whether this increase in expenditure on education and raising the salaries of teachers depends on the economic situation and selected macroeconomic indicators, or whether this increase is independent of these indicators. In the context of the development of monitored indicators since 2011, it has been found that the increase in total expenditure on primary education is due to a combination of the growth of the number of teachers and their salaries and the economic situation (GDP) is virtually independent. It should be pointed out again that increasing expenditure on education without changing the quality of teaching is only a consumer expenditure and not an investment that increases the added value of young people on the labor market. Therefore, it is necessary to appeal to the overall change of the system and increase the qualifications of teachers who will transmit information and knowledge in a way that future generations will appreciate.

Keywords: education; expenditures; public finance; salary; pupil-teacher ratio

JEL Classification: H41; I28

1. Introduction

Especially at present, education is one of the most important sectors of the public sector, which is financed from the public budgets. One of the general assumptions is that the level and quality of the achieved education positively affects the economic, cultural, and social development of the country (Kadnikova & Kolesov, 2019; Macris et al., 2011; Szarowska, 2016). International studies (Bracke et al., 2014; Kondirolli & Sunder, 2022; Weare, 2007) also prove that the achieved education positively affects the life of an individual not only from an economic point of view but also from a psychological. These people are characterized by positive self-evaluation in the areas of health and show a higher interest in politics and interpersonal solidarity (Szarowska, 2016).

An important topic in the field of educational policy is also the idea of lifelong learning, which has already been discussed in the 1970s. From the beginning, it has been, and will probably still be associated with three phenomena, which are “maintaining economic development of society, the concept of human resources as an engine of economic

development, and creating conditions for human resources" (Glastra et al., 2004; Pham & Klamma, 2013; Sung & Freebody, 2017). Economics and education relations appear to be mutually influencing (Hedvicakova & Svobodova, 2018a; 2018b). Economic growth is conditioned by the high-quality education of people, as well as quality education of people requires increasing resources, which must be secured by a functioning economy (Chikoko & Mthembu, 2020; Ismanto, 2016).

Thus, the level of the economy directly affects the level of education and, on the contrary, education plays an important role in the technological and organic development of the economy of the state. Currently, there is a right to speak of the irreplaceability of human capital, whose culture and readiness are paid by the professional public (Kholiavko et al., 2022). At the beginning of the 21st century, we record modern trends in the labor market. It is difficult to transform the structure of employment and at the same time there is a growing requirement for well-prepared human resources. The acquired knowledge and information become the main production factor. Each country provides a different type of knowledge and skills related to the overall structure of the national economy (Sun, 1999).

Education presents part of the educational system that provides people's education. The education system of the Czech Republic is represented by schools, school facilities, and human resources operating in these institutions (Průcha, 2015). The educational system can be characterized as a system with a pleasant education level of education. The educational system of the Czech Republic represents the function of socialization, educational, educational, qualifying, integrative, selective, protective, control, and innovative (Kalous & Veselý, 2006).

Compulsory school attendance in the Czech Republic begins at the age of 6 years of age and lasts 9 school years. Preprime education is provided to children aged 2 to 6 years, while the last year of preschool education is compulsory. The educational process is implemented in kindergartens for these pupils. The primary and lower level of secondary education is carried out in primary schools. 9 years are divided into the first and second levels. Lower secondary education can also be provided by multi-year grammar schools and conservatories. Higher secondary education is provided by secondary schools by both general and debt. The tertiary level of education is realized through higher vocational schools and universities, while high-teaching education is carried out within the bachelor, master's, and doctoral study programs (European Commission, 2023).

2. Methodology

As mentioned above, there is a bilateral dependence between the quality of education and the level of the economy. This paper aims to find out whether the investment in education (its financial support) only follows the trend of other macroeconomic indicators or whether the government supports basic education beyond this trend. The empirical part of the article is based on data analysis published by official national and international institutions. This analysis can be divided into two partial parts.

In the first part, there is an international comparison of indicators concerning basic education in the countries of the Visegrad Group (Czech Republic, Poland, Slovakia, Hungary) and OECD. To obtain a basic overview, there is a comparison of education expenditure to GDP. The relevant

data between 2001–2020 from the World Bank are used. Furthermore, there is an international comparison of indicators "Number of pupils per teacher at elementary school" and "average annual salary of teachers". This comparison is based on OECD data for 2020. These are indicators that are used to assess the significance and sometimes efficiency of education. It is assumed that higher education expenditure is a source of the higher added value of human work in the future. At the same time, it is assumed that the lower number of pupils per teacher leads to the higher efficiency of the sources directed to the increase in education and qualifications of each individual.

The second part of the analysis is devoted to the Czech Republic and the development of partial values of indicators relating to primary education (number of pupils, schools, teachers, education expenditures, average wages of teachers). These indicators are presented in the context of the development of basic macroeconomic indicators (inflation, GDP growth, average wages, and government expenditures as a whole). The data for the period 2011–2021 is used, which is a compilation of data collected by different institutions – the Ministry of Finance, the Ministry of Education, the Czech Statistical Office, and the Czech National Bank. The link between the monitored indicators is identified by the correlation analysis. Pearson correlation coefficients are presented, and the level of alpha = 0.05 and 0.01 is used to determine the significance of the correlation.

3. Results

3.1. International Insight

Organizations of basic education may differ significantly within individual countries. For the most part, it depends on the deployment of elementary schools (for example, whether municipalities with fewer people provide basic education or part of it, even for the youngest children). Schools in smaller municipalities are not so large that they can compete with their capacity to large elementary schools in large cities. At the same time, there may be relatively fundamental differences in the wage evaluation of pedagogical staff between countries.

There may also be significant differences in terms of class occupancy. While smaller schools may have a relatively low number of pupils in the classes, this number is usually much higher for larger schools. For example, in the Czech Republic, the number of pupils in the class should be ranging from 10 (small schools that only operate the first level of primary education) up to 30 (maximum number of pupils in the classroom for all schools) (Decree of 22 June 2018, Amended Decree No. 48/2005 Coll., On Basic Education and Some Essentials of Compulsory Education, as Amended, 2018).

Due to the different numbers of pupils in the class, the number of pupils per teacher also differs. It is therefore clear that in terms of wage costs, it is more effective to have a higher number of pupils in the class. In most cases, the remuneration of teachers is not followed by the number of pupils who teaches but is determined by the so-called tariff salary. The difficulty of pedagogical activity can be taken into account, for example, in the form of rewards, which are, however, a variable component of salary. The independence of the average salary of the teacher and the number of pupils per teacher is proven by the graph below (Pearson's correlation coefficient in this case reaches only 0.144).

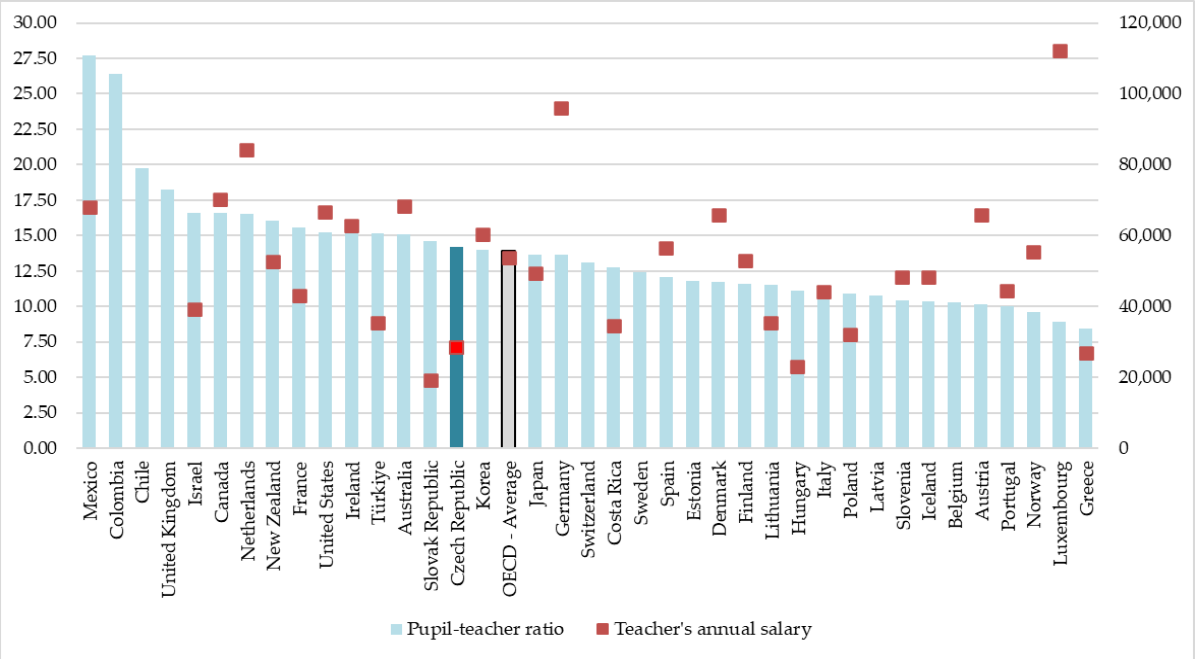

Figure 1. Number of pupils per teacher and wage of teachers, own processing according to OECD data (OECD, 2022, 2022)

The Czech Republic reaches similar values in these indicators to other Visegrad Group countries. From the point of view of the "number of pupils per teacher", it can be stated that together with Slovakia is very close to the average of all OECD countries (13.94). In the Czech Republic, 14.21 pupils per year per teacher in 2020, and Slovakia, it is 14.62 pupils. On the contrary, Poland and Hungary have more teachers in the converted to pupils - per teacher in Poland is an average of 10.88 pupils, and in Hungary, it is 11.11 pupils. However, teachers' salaries are different in these four very similar countries. The Polish teacher earns an average of $ 32,039 per year, approximately $ 13,000 more than the annual salary of a teacher in Slovakia. If we compare the expenditure of the state on education to GDP, it turns out that this share is very similar to all V4 countries and has been between 3.52 and 5.79% in the long term (see Figure 2). For the sake of completeness, it is necessary to add that in the Czech Republic there was a steep growth in elementary education in 2016 and 2017 due to the introduction of so-called inclusive education (inclusion of all pupils with specific educational needs into regular schools).

3.2. Basic Education in the Macroeconomic Context in the Czech Republic

In the case of the Czech Republic, the number of teachers has increased over the past ten years. While in 2011 only 58,815 teachers taught at primary schools, in 2021 71,325 teachers worked at elementary schools, which is an increase of 21.27%.

The growing trend in the number of teachers is also the cause of a significant decline in the number of pupils per teacher. In addition, this decline is supported by a demographic factor – a different number of children born in individual years, which changed by up to 10% (ČSÚ, 2022) during the period under review. However, the work of the teacher at elementary school is stable and largely independent of short-term demographic changes. Therefore, in the future, short-term fluctuations in the number of pupils per teacher will fall. In terms of economic impacts, this is not negligible at all.

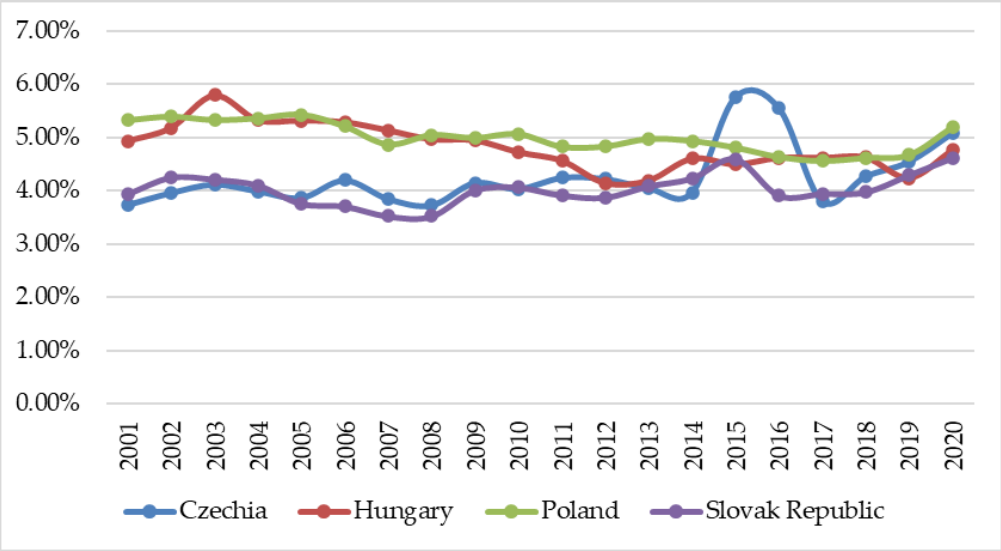

Figure 2. Education spending on GDP with V4 countries. Own processing according to (World Bank, 2022)

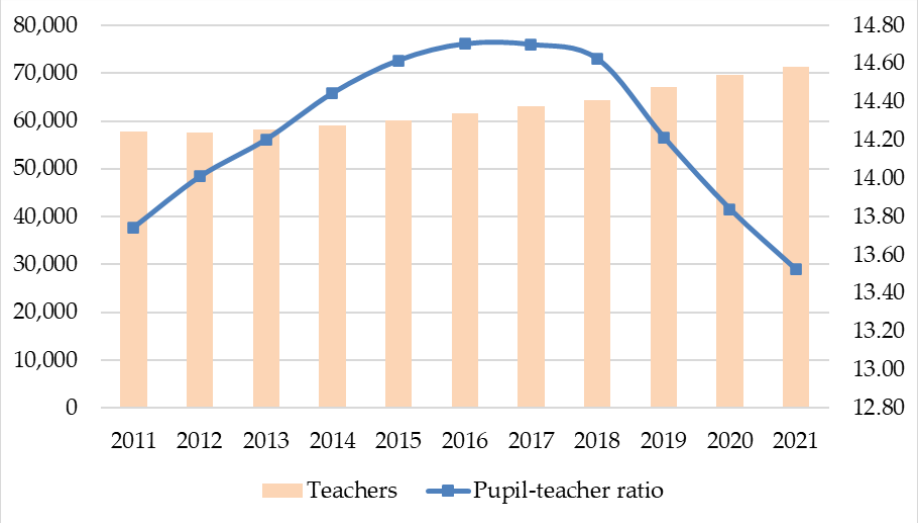

Figure 3. Development of the number of teachers in primary schools and the number of pupils per teacher between 2011–2021. Own processing according to (ČSÚ, 2023a; MŠMT, 2023)

The growing trend in the number of teachers is also the cause of a significant decline in the number of pupils per teacher. In addition, this decline is supported by a demographic factor – a different number of children born in individual years, which changed by up to 10% (ČSÚ, 2022) during the period under review. However, the work of the teacher at elementary school is stable and largely independent of short-term demographic changes. Therefore, in the future, short-term fluctuations in the number of pupils per teacher will fall. In terms of economic impacts, this is not negligible at all.

A growing number of teachers requires an increase in wages, while wages make up most of the expenditure designed to finance education. As a result of economic growth and the tendency to increase the prestige of teachers, politicians often emphasized the need to increase teachers' salaries. However, increasing salaries in combination with the increasing number of teachers has a multiplication effect, and expenditures into education are beginning to have the potential for exponential growth.

This growth is not bad in principle, as it could achieve the primary goal of raising salaries in education as an investment - gaining above-average quality and capable teachers who can desire to educate further generations of people and increase their added value on the labor market. In this context, it is necessary to take into account the overall macroeconomic context - there is an increase in wage expenditures (and thus also expenditure to primary education) regardless of other macroeconomic indicators, or is this growth of expenditure only copy GDP or inflation growth? The answer may be provided by the following graph, from which, with some exceptions, the growth of all three monitored sizes – inflation, state budget expenditure, and GDP is evident, with some exceptions.

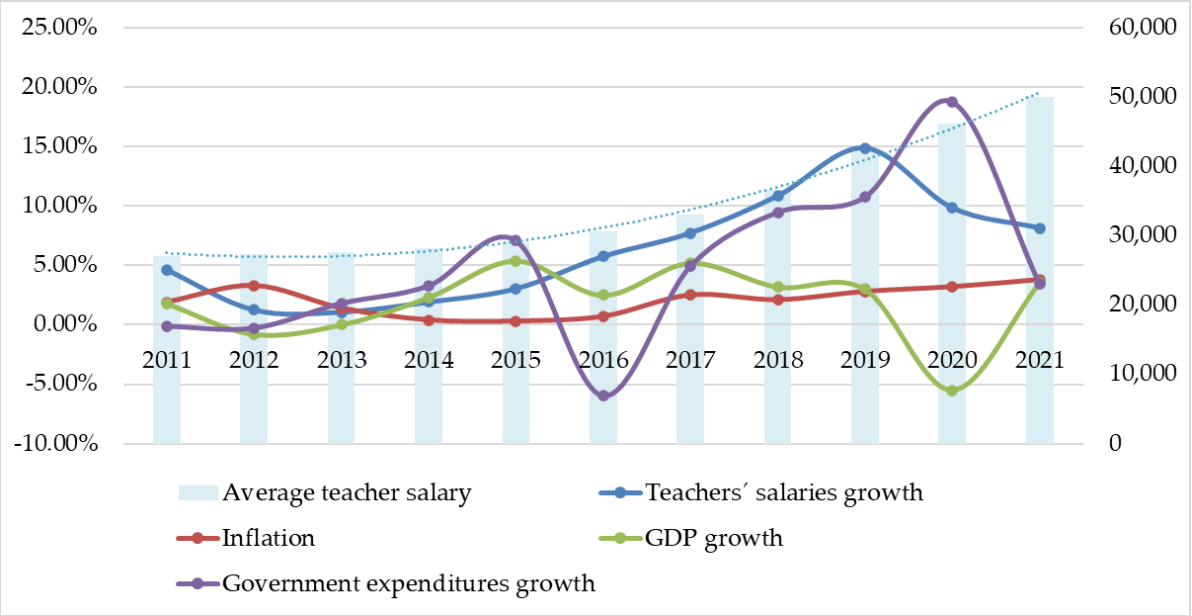

Figure 4. Development of the average salary of teachers at primary schools, teachers' wage growth, inflation, GDP growth, and growth in state budget expenditure in 2011–2021. Own processing according to (ČSÚ, 2023b, 2023c, 2023a; MŠMT, 2023)

Practically all monitored macroeconomic indicators show a very high degree of correlation with education expenditure (see Table 1). The only exception in positive dependence is GDP growth. We can interpret this fact in such a way that the expenditure on education, including the growth of teachers, is independent of economic growth. This is not a surprising finding - basic education is one of the primary economic estates that the state provides to its citizens (children) regardless of the economic situation.

However, the warning signal is elsewhere: no significant link between GDP growth and other indicators was found during the period under review. In practice, this means that, despite the improving economic situation (GDP growth), there are no demographic changes that would be reflected in the future, for example, in a steadily growing number of pupils. The decreasing number of pupils subsequently (under otherwise the same conditions) would lead to a reduction in the number of pupils per teacher, which can gradually approach some developed countries (e. g. Germany, Norway, Luxembourg. However, this would only be a partial success. In recent years, it has also assumed maintaining the current number of pupils. If the birth rate is reduced and thus a few years later the number of pupils, then there

may be disproportionately high expenditure on pedagogical staff who will have a half-empty class. Despite high education, he made it impossible to continue the growing trend in remuneration of the quality that the whole education system so much needs.

Table 1. Correlations

Data 2011-2021	Scholls	Classes	Pupils	Teachers	Expenditures (basic	Expenditures (education)	Expenditures (total)	GDP growth	Inflation	Average teacher	Average wage (CZ)
Scholls	1	.99**	.91**	.99**	.98**	.97**	.94**	-0.09	.63*	.98**	.99**
Classes	.99**	1	.96**	.99**	.96**	.95**	.93**	-0.04	0.53	.96**	.98**
Pupils	.91**	.96**	1	.92**	.87**	.84**	.81**	0.08	0.37	.86**	.91**
Teachers	.99**	.99**	.92**	1	.99**	.98**	.96**	-0.12	.61*	.99**	.99**
Expenditures (basic education)	.98**	.96**	.87**	.99**	1	.99**	.97**	0.17	.66*	.99**	.99**
Expenditures (education)	.97**	.95**	.84**	.98**	.99**	1	.97**	0.20	.70*	.99**	.99**
Expenditures (total)	.94**	.93**	.81**	.96**	.97**	.97**	1	0.25	.63*	.98**	.95**
GDP growth	-0.09	-0.04	0.08	-0.12	-0.17	-0.12	-0.25	1	-0.35	-0.18	-0.11
Inflation	.63*	0.53	0.37	.61*	.66*	.70*	.63*	0.35	1	.67*	.65*
Average teacher salary	.98**	.96**	.86**	.99**	.99**	.99**	.98**	0.18	.67*	1	.99**
Average wage (CZ)	.99**	.98**	.91**	.99**	.99**	.99**	.95**	0.11	.65*	.99**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4. Discussion and Conclusion

A very discussed topic in the Czech Republic is to increase spending on education. The arguments for increasing these expenditures and salaries of pedagogical staff are mainly for improving the quality of education (Benesova et al., 2015). The amount of teachers' salary is one of the factors for many secondary school graduates to decide whether to remain in education and the teacher's career will start (Figlio, 1997). It is not surprising that higher salaries have the potential to attract young people to education, which can pass on further generations' knowledge in such a way that economic exploration is an investment in the future.

The following can be stated based on the analysis performed:

- The Czech Republic has an average number of pupils per teacher compared to other OECD countries, but the salary of teachers is about half compared to these countries.
- Expenditure on education has increased significantly in recent years, this growth was caused by increasing the number of pedagogical staff and growing their wages.
- The economic situation (GDP growth) had virtually no effect on the number of pupils in the period under review.
- Although the growing number of teachers and their wages significantly increase education, without further changes in the education system (e. g. improving the quality

of teaching, taking into account modern technologies and trends), these expenditures do not become an investment that would increase the added value of the pupils and the potential of their application future.

In connection with the above findings, it is necessary to take into account the quality of education as a whole before further increased increase in education. Increasing wages or the number of teachers in itself cannot contribute to a higher quality of education, as some politicians mistakenly believe. Wage increases are only consumer expenditure and a tool in which the teacher's position can be promoted to socially popular and desired. But only a change in the approach to education and a quality way of education, which can be implemented by quality educators, can provide the much-needed compulsory basis of education and turn this consumption expenditure into an investment.

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Hybrid Project Management: A Literature Review

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Abstract: After a wave of traditional and agile project management, there has been a visible period of blending these archetypal approaches in their combination, represented by hybrid project management. Although it has received considerable attention in the literature and practice, this phenomenon needs more conceptualization, clarity for the whole approach, explicit anchoring, and clear boundaries. This paper aims to define the meaning of hybrid project management more firmly through a narrative review that analyses the delineation of existing research and critical synthesis. The output also clarifies the blurred boundary between the edges of hybrid and traditional or agile project management. The benefit of this anchoring is the cultivation of the project management scene and the attempt to limit vagueness and misuse of the term.

Keywords: hybrid project management; project management approach; literature review; traditional; agile

JEL Classification: O32; O21; H43

1. Introduction

Organizations address increasingly complex initiatives, problems, and requirements in today's rapidly changing environment, putting pressure on them to adapt continuously to dynamic conditions (Horney & O'Shea, 2015). These conditions, sometimes referred to as the VUCA world, an abbreviation for volatility, uncertainty, complexity, and ambiguity (Bennett & Lemoine, 2014), create new project management (PM) challenges (Papadakis & Tsironis, 2018).

After a period in which traditional project management (TPM) dominated the project management field and after the subsequent 20 years of development of antitheses represented by agile project management (APM) and mutual delineation (Gemino et al., 2021), attempts to combine these two archetypal extremes were made. The effort to find optimized combinations based on multiple, typically conflicting methodologies has led to the emergence of various methods or frameworks collectively referred to as Hybrid Project Management (HPM).

Based on positive experience and research results, we observe a gradual development of hybrid methods that optimize project outputs by combining multiple methodologies at different levels. Despite this success, across the hybrid project management phenomenon, we face the problem of unclear boundaries of what is still HPM and what is not. For example, Serrador and Pinto (2015) found the prevalence of "hybrid" Agile methods. They suggested focusing on companies, which formally adopted a hybridized version of Agile, and their

research has found that the hybrid approach applies to most projects. For a measure, they asked respondents to indicate the amount of effort spent planning during the planning and execution phases and constructed the Planning effort index and Agile planning index. The indices differed in the numerator – total effort expended during the planning phase was used for the Planning effort index, and total effort spent on planning after the planning phase was used for the Agile planning index. Gemino et al. (2021) used a 5-point Likert-style format which asked respondents to identify the percentage of agile practices used in their project. Projects in the highest category with agile practices, between 80% and 100%, were categorized as agile, and projects in the lowest category with agile practices, between 0% and 19%, were considered traditional. The remainder of the scale results in categorizing the projects as a hybrid. The authors justified the 20% cut-off as reasonable because it constitutes reasonable use of the other approach since "the definition of hybrid is combining practices from agile and traditional approaches" (Gemino et al., 2021, p. 165). Different studies define the approach differently, commonly referring to a specific case of a combination of agile and traditional approaches, but other varieties exist. There is only fragmented knowledge about the hybrid approach (Reiff & Schlegel, 2022). What constitutes HPM is unclear, and the determination of what combination of agile and traditional approaches is enough needs to be clarified. Is a traditionally planned project with a work package organized with Scrum hybrid? Or an agile IT project with set milestones and 10% of requirements planned upfront? Academia and practice have made efforts to determine when it is appropriate to use HPM, while at the same time, it is not obvious what is and what is not HPM.

Another motivation for refining the definition of HPM is the desire to cultivate the field of project management so that the term is not misused similarly to Agile. In the same manner, as the naming of Agile has been used to refer to poorly or loosely managed change, HPM can be used to name projects that are not consistently following one of the methodologies, if not anchored.

By the narrative review method, this paper looks at the definitions and delineation of HPM in previous research on the phenomenon. Based on these inputs, we do not attempt to provide the reader with a raw average of these definitions but to further refine it through critical analysis and outline the phenomenon's boundaries. This method aims to answer the question of what hybrid project management is and whether it fits the current VUCA world.

2. Methodology

This study focuses on type 3 research, which reconciles the need for theoretical development and engagement with practice and encompasses the meso level dealing with project-level explorations according to Geraldi and Söderlund (2018) framework. We conducted a narrative literature review to answer the research questions utilizing objective, comprehensive and critical analysis of current knowledge. For practitioners, it helps create a reliable knowledge base that can be used for evidence-based decision-making, and for academics, the review process increases methodological rigor (Tranfield et al., 2003).

To ensure a systematic, transparent, and rigorous process as possible, we followed the comprehensive guidance of the PRISMA 2020 statement (Page et al., 2021). We searched two of the largest and most popular (Paul et al., 2021) bibliographic databases, Scopus and Web of Science.

Search strings are listed in Table 1. As we planned to use machine learning tools to prioritize the screening, we kept the search string very simple to ensure that relevant studies were not omitted due to the over-specificity of the search.

Table 1. Search strings

Database	Search string
Web of Science	hybrid project management (Topic) Refined By: Document Types: Article or Proceeding Paper or Review Article
Scopus	TITLE-ABS-KEY (hybrid AND project AND management) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp") OR LIMIT-TO (DOCTYPE, "cr") OR LIMIT-TO (DOCTYPE, "re"))

For screening records, we used ASReview, which uses active learning to train a machine learning model that predicts relevance from texts using a limited number of labeled examples (van de Schoot et al., 2021). The resulting number of search records was in the thousands, and it would be too time-consuming to screen them manually. However, using the tool eliminated this disadvantage, as we assumed based on previous experience. ASReview not only offers a much quicker way to select relevant literature than screening by hand, but it also automatically logs every screening decision, which benefits the transparency and reproducibility of the reviewing process (van Ruitenburg & Ruiter, 2022).

Records that passed screening were then sought for retrieval of the full text. Only studies in English were included, so there was no need to translate abstracts or full texts of articles. Table 2 lists the inclusion and exclusion criteria used to assess eligibility for inclusion in the review. For eligible articles, relevant information related to descriptive data (type, title, authors, year, DOI, etc.) and information relevant to the research question were extracted in a structured fashion using an extraction table in Microsoft Excel.

Table 2. List of inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
HPM is an objective of the article.	The article text is not in English.
The definition of HPM is included.	There is no full text of the article available.
	The article does not address the research question.
	The article is duplicate report of the same study.
	The article is a teaching case only.

Full texts were read from start to finish. They were inductively coded using initial codes (Gaur & Kumar, 2018; Xiao & Watson, 2019) in MAXQDA2022. We utilized theoretical thematic

analysis (Braun & Clarke, 2006) to analyze the coding outcome. An online platform, Miro, was used for effective collaboration among the authors and as support for visualization.

3. Results

We found 6,129 records in database searching (3,885 in Scopus and 2,244 in Web of Science). Deduplication was performed, and we screened 4,623 abstracts of records using ASReview, a machine learning-aided tool applying active learning (van de Schoot et al., 2021). After the screening, we retrieved 91 full-text papers, assessed them for eligibility, and included 46 papers. In addition, we searched the references of the originally included studies. Additional 36 full-text documents were retrieved and assessed for eligibility, and 16 fulfilled

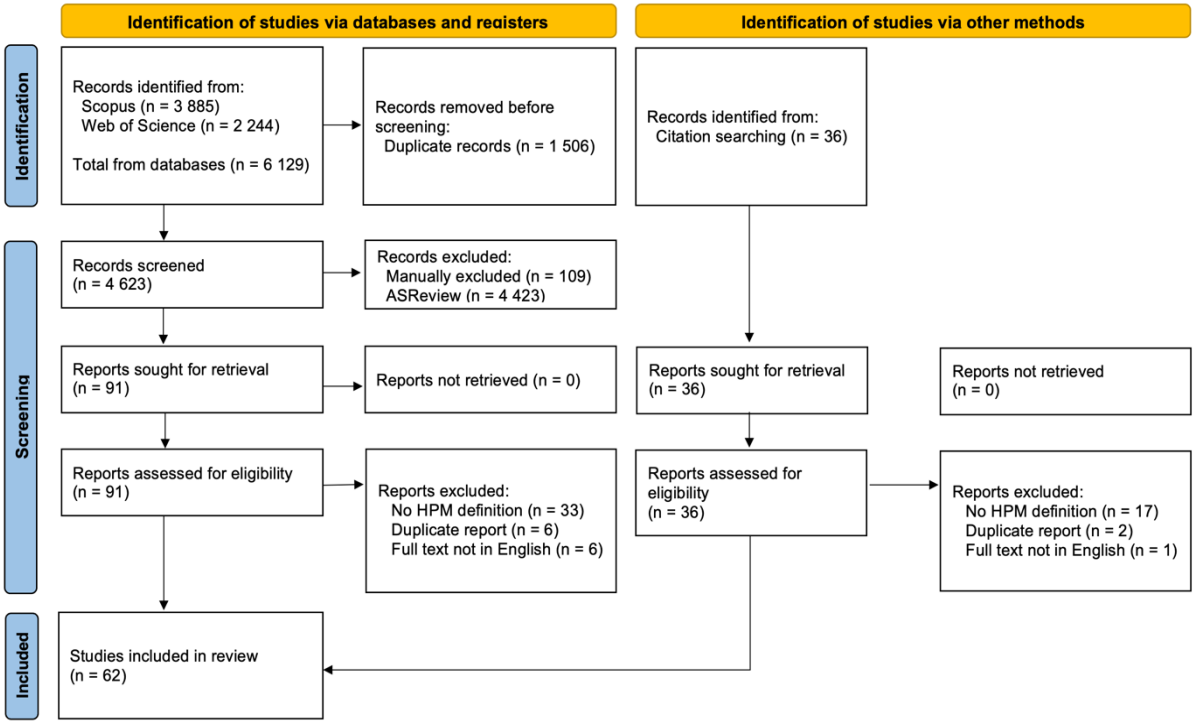

Figure 1. PRISMA flow diagram

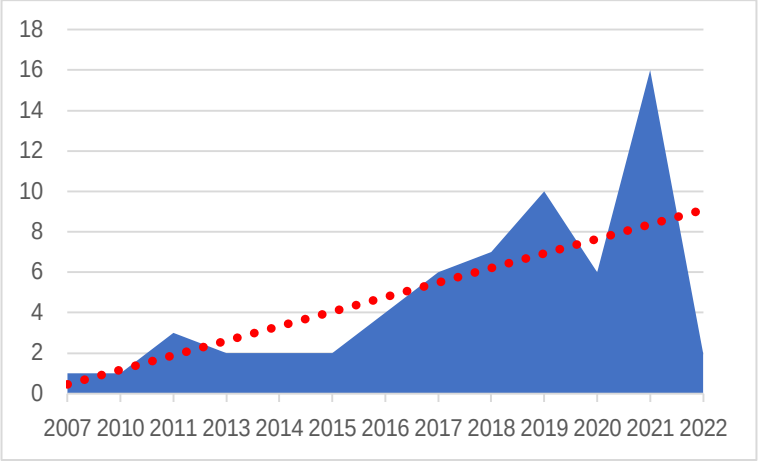

Figure 2. Time distribution of included studies

inclusion criteria, resulting in a total of 62 studies included in the review. The detailed flow diagram is shown in Figure 1. As visible from Figure 2, HPM is a topic that has been the subject of scientific research in recent years. The number of studies found in 2022 is low because the search was performed in the first quarter of 2022.

Before we can discuss what defines the boundaries of hybrid project management and where they lie, it is necessary to answer what we are talking about. Is hybrid project management a method, a methodology, a framework, an approach, or a combination of practices? Even this initial question varies from research to research, and these terms are treated loosely (see Table 3). More than half of the included articles use the term approach, the term model is also often used, and the term method or methodology is also repeated. Other designations are not typical and are relatively rare.

Table 3. How is HPM referred to in the literature

approach	32
model	14
method	5
methodology	3
development process	3
framework	2
development lifecycle	1
best-practice	1
combination of practices	1

Table 4. What is combined in HPM according to the literature

agile and traditional	24
agile and stage-gate	9
agile and plan-driven	7
agile and waterfall	7
different approaches/models	4
adaptive and predictive	2
agile and conventional	2
agile and rational unified process	1
agile and waterfall/stage-gate	1
agile and waterfall/V-model	1
agile and predictive approach	1
agile and waterfall and lean	1
agile and non-agile methods	1
agile and waterfall, engineering practices and improvement methodologies	1

As part of the analysis, we also analyzed how the components that the hybrid creates are described (see Table 4) and whether the HPM description also includes the reason for creating the HPM (see Table 5). The vast majority of articles define HPM as a combination of agile and other components. Four articles generally describe that a hybrid is created by combining different approaches, and two studies mention a combination of predictive and adaptive

methodologies. As for the component combined with agile, the label traditional alternatively conventional predominates. Individual studies often use waterfall, plan-driven, stage-gate, and V-model, especially in fields where these terms merge with traditional project management approaches.

The reasons for the emergence of HPM are the most variable in the literature. The most common goal is to obtain the advantages of a combination of approaches, eliminate their disadvantages, or both. Nine studies cite adapting the methodology to their needs as a reason. Seven articles highlight the introduction of agile elements into traditional PM. Other reports also mention project success, project performance, balancing flexibility with a structured approach, or, more generally, obtaining a more effective model for project management available.

Table 5. What is the reason for creating HPM according to the literature

to gain benefits of both	16
to customize to the needs	9
to reconcile the traditional approaches with agility	7
project success	6
combining the strengths while suppressing weaknesses	5
project performance	5
to balance structure and flexibility	5
to develop an effective model	4
to negate the disadvantages	3
to comply with constraints	1

4. Discussion

4.1. Anchoring HPM

The emergence of HPM and the appropriateness of its approach to PM is supported on a theoretical level by the project contingency theory (Howell et al., 2010) and the associated body of work, which states that not all projects are the same, and therefore they should not all be structured and managed the same way.

Project management has many descriptions, but one of the respected and cited definitions is Packendorff's formulation stating that PM can be described as “a set of models and techniques for the planning and control of complex undertakings” (Packendorff, 1995). It is a concept including multiple theories applicable to different projects considering that publications often differ in their prescriptive or descriptive attitude. Here hybrid project management builds primarily on its descriptive approach, which is based on the analysis of use cases in the company where a specific methodology was formed. This is the approach that Packendorff recommends for future project management research and is in direct opposition to the academic attempt to build a specific prescriptive framework.

Hierarchically, we equate HPM with APM and TPM. Neither is a specific methodology or framework that contains a specific prescription for how to lead a project or temporary organization under given assumptions. However, both mentioned above represent several of these methodologies that share the same principles or values. For example, ISO 21500 and

the first versions of the PRINCE2 and PMBOK standards are representatives of TPM (although they can no longer be clearly defined as such because recent versions of international PM standards have already incorporated agile into possible PM approaches: e.g. PRINCE2 Agile or PMBOK 7th Edition). Similarly, APM includes, for example, Scrum, Adaptive Software Development, Extreme Programming, and others. At the same time, TPM and APM are approaches that are defined by a series of characteristics, principles, and values that defines the approach.

We look at the definition of HPM at the meso level, which represents the classic project management body of knowledge, including project-level explorations, collaboration, cooperation, coordination problems in projects, time management, and communication management (Geraldi & Söderlund, 2018). Through this lens, the hybrid concept fulfillment is represented by the combination of the sub-elements of a project, not by a combination and dependencies of several projects with different methodologies which would form a program.

The most significant intersection between the analyzed definitions of hybrid project management is that it combines several diverse methodologies. Furthermore, publications agree that one of the characteristics is the objective of selecting from the mentioned methodologies their advantages, avoiding their disadvantages with the vision of providing more successful projects. Beyond this typical minimum, publications often differ in what is combined from these methodologies, whether we combine practices, principles, or methods.

In order to get rid of the current vagueness of the definition of hybrid project management, we need to pay attention to its boundaries. As mentioned above, HPM is not a specific methodology but a PM approach mixing traditional and agile methods, not least because it does not tell us the specific elements of other methods that must be included. The definitions of hybrid project management described above do not show the sharp boundaries of HPM itself and, therefore, implicitly indicate the boundaries where traditional and agile methodologies end.

In traditional methodologies, tailoring has long been the method of choice. That is the systematic departure from a particular traditional methodology in favor of other elements that better fit the environment of a given organization or project. This practice was common before the advent of hybrid methodologies. The same way tailoring is worked with in agile methods.

A characteristic of hybrid project management is combining practices from methodologies on the opposite spectrum (Prenner et al., 2021). On the other hand, contradictory principles, and values that, by their very nature, should be running through the dominant part of the methodology are not typically combined in the HPM approach. HPM is characterized by a value or ideological emptiness distinct from traditional PM and agile. It is replaced by a cold pragmatism to replace less effective elements with more appropriate ones to achieve better results. Therefore, in HPM, we cannot expect the analogy of the Agile Manifesto (Beck et al., 2001). HPM is a field where we are unwilling to accept the disadvantages of one practice in favor of a consistent value-based approach. The emptiness is a potential strength of HPM and a differentiation from only tailored agile or traditional methods. Moreover, given the dominant definition of HPM as a combination of agile and

traditional methodologies, the combination of multiple only agile or multiple only traditional methods lies beyond HPM. Related to this is that existing definitions repeatedly mention the balance of chosen practices as a characteristic of HPM (Bick et al., 2018; Binder et al., 2014; Dabney & Arthur, 2019).

In addition to the questions of what the HPM is and where its boundaries lie, it is helpful to summarize what it contains. As mentioned above, previous efforts to frame HPM do not see it as a system that has adopted values or principles. Instead, they often speak of a set of adopted practices or methods. Publications often avoid explicit content or only mention the adoption of strengths. More specifically, focused definitions talk about HPM adoption and therefore being constituted by processes, practices, roles, and tools (Bagiu et al., 2020; Brown et al., 2020; Dinis et al., 2021). Some constraints even expect a specific method, for example, the stage-gate model (Cooper & Sommer, 2016). However, these isolated occurrences do not attempt a general definition of hybrid project management.

In order to fully define hybrid project management, the aspect of time or the intended target state of the methodology needs to be girded. HPM is not a framework for gradual implementation from one to another pure methodology when an organization decides to phase in a combination of practices that would be temporary. When we talk about HPM, it is intended to be a goal-based, long-term approach to project management, although this is only implicit in the definitions of HPM, and none of them states it explicitly. It is, therefore, not an alternative to introducing a new PM methodology in a big-bang way.

As noted above, despite the extensive research on HPM, it is not easy to find corresponding specific HPM methodologies and frameworks which are more widely used in practice. Therefore, it is impossible to speak of HPM as a group of methodologies. However, as the results of our review show and as this paper illustrates below, it is possible to find specific characteristics and anchors of hybrid project management as an approach to project management.

After analyzing the individual aspects, we can put their conclusions into a comprehensive definition of HPM as follows:

Hybrid project management is a project management approach combining elements of traditional and agile project management to gain advantages and suppress the disadvantages of both to increase project success. It balances flexibility, effectiveness, productivity, and project control. The ability to customize the combination to the specific needs makes this approach suitable for project management in various contexts.

At the same time, the out-of-scope definition in the wording that HPM is not tailoring APM or TPM, nor is it a combination of practices within one of them, nor is it a temporary combination of practices during the transition from one approach to the other. We have depicted these PM approaches as forming what we call the project management approach continuum in Figure 3.

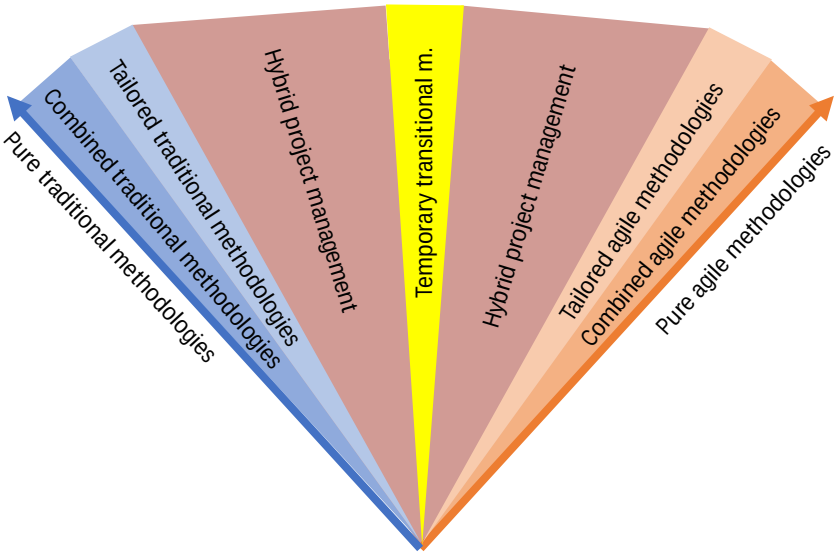

Figure 3. Project management approach continuum

4.2. HPM in the VUCA World

In today's VUCA world, project management is a key competency. We analyzed the individual characteristic attributes of the VUCA concept and the affinity with individual PM approaches (see Table 6). HPM appears to be a suitable approach, which is also confirmed by surveys from recent years when this approach is rapidly gaining popularity and becoming the predominant method of project management (Digital.ai, 2021; Gemino et al., 2021).

Table 6. Suitability of the PM approach

Attribute	Challenge description	TPM	APM	HPM
Volatility	The change happens more often than in the past, it is faster and has a much greater impact.	No	Yes	Yes
Uncertainty	The number of changes and their great impact means that we are working with increasing uncertainty. What is true today may not be true tomorrow.	Partly	Partly	Yes
Complexity	Everything relates to everything. There are many non-linear connections, and it is difficult to determine simple contexts. This not only prevents us from being easy to understand, but it mainly prevents us from finding simple solutions.	Yes	No	Yes
Ambiguity	Volatility, uncertainty, and complexity cause that there is no single truth, the only right solution.	Partly	Partly	Yes

Although TPM can deal with change, it is an undesired complication and deviation from the plan. On the contrary, APM embraces the change, and this feature is also carried over to HPM.

As for uncertainty, TPM partially deals with it through risk management and APM through postponing decisions until they are needed at the latest. HPM can combine both, achieving even better results.

While TPM can deal with complexity very well through decomposition and planning, in APM, too many dependencies and the need to cooperate with many resources is a problem. In this case, HPM can maintain control of the hybrid and combine this with flexibility where possible.

And finally, TPM partly helps the principle of tailoring and APM adaptive development, but in terms of methodology, both approaches present themselves as a solution that suits everyone. In contrast, HPM is an ideal example that there is no single right solution, and with "built-in" customization, it can fully cope with the challenge of ambiguity.

4.3. Recommendations for Research

Among the opportunities for further development, we see room for the further concretization of hybrid project management, specifically through exploring appropriate combinations of practices in specific settings and iteratively combining them. An additional research opportunity is to investigate the link between the project type, its implementation environment, and the appropriate form of hybrid project management. Furthermore, a view of HPM from the perspectives of project participants is missing. For example, exploring how they operate between practices that have no unifying line.

4.4. Recommendations for Practice

The use of the hybrid approach in practice is increasing. According to recent surveys, most projects already use a combination of project methodologies (Gemino et al., 2021). Project leaders and organizations need to become familiar with this approach, know its merits and weaknesses, and apply it where appropriate. Grounding and knowing what HPM is and what it is not will help practitioners in further education and adoption of HPM in their organizations.

Firms should examine their motivation for hybrid project management. HPM is characterized, among other features, by its motivation to optimize project outputs. However, if, for example, firms mix different practices simply because they are unwilling to invest effort in full-fledged traditional management, this approach may manifest in inferior results.

4.5. Limitations

In our research, we are aware of several of its limitations. The most obvious limitation is that this field is still in its infancy compared to other areas of project management. In general, the preliminary work is limited to a subset of a few scientifically written articles and a few coherent findings. Also, there are not many empirically based studies, and those that exist are limited by field, sample size, product type, or project specifics. While existing cases are valuable and illustrate a wide range of applications, they represent only a small subset of limited relevance.

Most of the articles, especially the case studies, report positive results of using hybrid project management and connect the successful execution of projects with the choice of methodology without corresponding rigorous analysis. We, therefore, point out that publication bias must be considered. Furthermore, we are aware of the limitation resulting from the choice of keywords. In some publications, the same phenomenon can have a different label than hybrid project management. Therefore, such studies can escape our analysis despite citation searching, which helps avoid this limitation.

The inconsistent quality of individual studies is also a limitation that must be considered. Even though the methodological rigor of some papers is shallow, we intentionally did not incorporate methodological quality as the exclusion criteria. By excluding some mainly qualitative studies, we would lose some valuable insights. At the same time, doing so would introduce the opposite constraint (Reiff & Schlegel, 2022), which we avoided following the recommendations of Kitchenham and Charters (2007).

5. Conclusions

Despite the growing interest in the field of hybrid project management and the strong base of existing research, we face the problem of the inconceivability of the HPM phenomenon. This is evidenced by the vagueness of definitions in the existing literature, their complete absence, and differences.

This paper responds to this gap by defining hybrid project management more precisely and answering sub-questions that clarify its boundaries. These questions include what it is, what it contains, and where it ends in relation to traditional and agile management.

The conclusions of these questions may help us cultivate the project management scene and make better decisions about the appropriate approach for a given environment.

This paper has defined the meaning of hybrid project management through a narrative review that analyzed the delineation of existing research on the phenomenon and a critical synthesis of it. HPM is a suitable approach to project management in the VUCA world.

Conflict of interest: none.

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Discrete-event Simulation and SIMPROCESS Software Usage in Project Management

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Abstract: Simulation modeling and project management are two areas, classified partly under operational research, that are not usually linked. The inclusion of stochastic variables in project management in the PERT method introduced the use of simulations, especially Monte Carlo simulations, also in project planning and time analysis. Another use of simulations in project management is the application of discrete event simulation in project planning. When creating a simulation model, it is usually not distinguished whether it is a project or a process. From this perspective, the use of simulations in project planning is common. However, the opposite view, i.e. project planning with the inclusion of simulation, is not so common. This paper presents the use of the SIMPROCESS software in project management for time and resource analysis. An example describes benefits and drawbacks of the discrete event simulation in SIMPROCESS. The main advantage lies in the possibility of setting different probability distributions to generate the duration of each activity. But this can also be seen as a limitation. For the project manager it is essential to know how the simulation software works. However, a project simulation model can be useful for deeper "what if" or time/cost/risk analysis.

Keywords: project management; discrete-event simulation; time analysis; resource analysis; SIMPROCESS software

JEL Classification: C63; O22; C44

1. Introduction

The issue of project management is quite broad, and although various projects have been a part of human life since ancient times, it is only since the last century that more project management methods and tools have been widely used and described. One of the tools still used in project management today was proposed by Henry Gantt in 1910 and the Gantt chart is one of the pillars of project planning (Baron & Baron, 2020). Until the mid-20th century, projects were managed ad hoc, mostly using Gantt charts and various informal techniques and tools. Even with several war projects, it became clear that standardized methods and techniques were needed, especially for project planning. Gradually, two key methods for project planning and time analysis emerged - the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) along with a network representation of the project (Kerzner, 2013). Almost at the same time, the Monte Carlo simulation method was proposed by tree researchers John von Neumann, Stanislav Ulam and Nicholas Metropolis (Thomopoulos, 2013). Monte Carlo simulation is one of the simulation techniques applied to

iteratively evaluate a deterministic model with random number sets as inputs. It simulates the entire system repeatedly, each time randomly choosing a value for each variable from its probability distribution (Kwak & Ingall, 2009). Variables can be, for example, the duration of different activities in a project – therefore Monte Carlo simulation can be incorporated into project planning and time and risk management.

Project management covers several project phases – basic 3 as pre-project, project and post-project phase can be split into 5 phases defined in PMBOK guide (2017): project initiation, project planning, project execution, project monitoring and control, project closure. The methods and techniques for the project time management are usually used in the planning phase, where all activities to be carried out in the project need to be defined completely. The interdependencies of activities must be defined and they can be described by one of the network diagrams (AOA = activity on arrow or AON = activity on node) or in a Gantt chart (Kerzner, 2013). To be able to create a Gantt chart, a duration for each activity must be set. Time estimates can be made as fixed values – then the CPM method for the project length is used – or on the three-way basis with optimistic, most likely and pessimistic times for each activity for the PERT method calculation of the project time. Another possibility is the use of simulation which involves calculating multiple durations with different sets of assumptions (PMBOK, 2017). Monte Carlo simulation can be applied on any large or complex project as basic techniques for time management analysis such as CPM or PERT might underestimate project duration. In this sense project management and simulation modelling can be incorporated. Although simulation modeling is mainly focused on modeling diverse systems in order to analyze their functionality, find bottlenecks or assess the workload of workers, some simulation models (especially Monte Carlo simulations) are also devoted to project modeling. On the contrary, the use of simulation models for project planning is still not common in project management. As Doloi and Jaafari (2002) mentioned, while the development of computer-aided process simulation techniques had been speeding up recently, their usage for project definition and management is not very common. Likewise, one of the best-known project management software, MS Project, commonly includes CPM, PERT methods, network graph or Gantt chart, but does not allow simulation for time or cost analysis.

Despite the facts mentioned above, there are still many options for linking simulation modeling and project management using appropriate software. The aim of this article is to present the possibility of using SIMPROCESS software for project simulation for better management of project time and resources and to show advantages and disadvantages of discrete-event simulation usage in project planning. For the case study the real project analyzed within the bachelor's thesis (Košťálová, 2009) at the College of Polytechnics Jihlava, Czech Republic, is used (the author of this article participated in the thesis as a supervisor).

2. State of the Art

Simulation is a technique for replicating real situations, processes or activities in order to study the system and learn how it works, to find where the problems originate, to compare several variants of the model and select the most appropriate one, to show the possible real impacts of alternative conditions and courses of action, etc. (Banks, 1998). Because simulation

models use principles taken from mathematics and statistics, they are usually classified as operational research or management science problems (Turban & Meredith, 1994) where various models are designed to find the optimal solution or the optimal choice. The simulation itself usually does not have as its main objective to find the best alternative but it might help in this process. Likewise, we usually do not encounter a simulation model if we focus on the issue of project management. According to Banks (1998) the typical systems for which simulation models might be used are:

- Business process reengineering and management,
- Construction systems,
- Manufacturing systems,
- Transportation systems,
- Public systems: healthcare, military, natural resources,
- Restaurants and entertainment systems,
- Food processing,
- IT/Computer system performance.

In general, simulation is often used for modelling queuing systems where the entities (people, physical items, information) are moving through the system (Robinson, 2007). Project cannot be described like a queuing system but a queuing system can be a result of a project. Similar topics and applications are mentioned on the web pages of Modeling and Simulation conference (MAS, 2022) which is a part of International Multidisciplinary Modeling & Simulation Multiconference. In 24 applications are, except of those mentioned above, named also applications in:

- Customer Relationship Management,
- Decision Making,
- Enterprise Resource Management,
- Financial Planning,
- Infrastructure Planning & Design,
- Inventory Management,
- Project Management.

Project management techniques, especially the methods for the time, cost and resource management, are also part of operations research. However, in the current concept of operations research, these methods are not linked to simulation modeling. Nevertheless, the mention of simulation modeling is contained in the PMBOK, guide (2017), where it is recommended to use especially Monte Carlo simulations for time analysis or risk analysis. In addition to articles aimed at simulation modeling with the inclusion of projects, where the project is not understood in terms of project management and finding the so-called critical path, the most common connection between project management and simulation is the Monte Carlo method and CPM or PERT method. Those methods should help project managers to find out critical activities (usually forming a critical path) that determine the project duration. While CPM uses deterministic activity durations, PERT and simulations use

stochastic (probability) durations. PERT follows Beta distribution only (Premachandra, 2001), simulation can use several other probability distributions for the to estimate the duration of individual activities. Another advantage of Monte Carlo simulation is the ability to provide near-realistic estimation results by equating the probability value of each activity as a critical value (Barraza, 2011).

The combination of CPM/PERT and Monte Carlo simulation was widely used for the purpose of risk analysis in many project management studies. Tysiak and Sereseanu (2010) combined CPM and Monte Carlo simulation for the risk analysis in IT project. Karabulut (2017) applied CPM, PERT and Monte Carlo simulation in planning of construction projects. Hendradewa (2019) performed CPM-PERT and Monte-Carlo simulation analysis to assess and manage schedule risk in three main phases of construction project, such as: feasibility study, design, and construction.

In addition to Monte Carlo simulation, a discrete event simulation model can also be used for project management planning. Discrete event simulation (DES) is suitable for dynamic, stochastic systems that change in a discrete manner (Banks, 1998). DES is conventional for economic and business process models, such as production and manufacturing systems (Fousek et al., 2017), call centers and emergency medical services (Mathew & Nambiar, 2013) or queuing and shops functioning (Kuncová & Skálová, 2018). As it was mentioned above, simulation and discrete event simulation models are used in many areas and usually there is no separation if the simulation is aimed at project or a process. When looking for the papers connected with project management and simulation, more than 54 thousand of results were found in Web of Science (WOS) database – but when PERT/CPM added, WOS offers only 37 papers and the SCOPUS database 64 results. When DES added, only 5 WOS papers and 11 Scopus papers remained. For example Sadeghi et al. (2012) used DES for approximating the project completion time and the critical path in a stochastic resource-constrained project network; Liu et al. (2015) integrated model information with a simulation framework; Pinha and Ahluwalia (2019) presented an approach that aims to reduce project time and costs by allowing project managers to assess different scenarios using a software tool based on flexible discrete event simulation; Jie and Wei (2022) proposed an estimation approach that combines an improved Earned value management, CPM, PERT and Monte Carlo simulation. Lee and Arditi (2006) offered a stochastic simulation-based scheduling system comparing the outcome of CPM, PERT, and DES under different conditions such as different variability or skewness in the activity duration data, the configuration of the network, or the distribution of the activity durations.

3. Methodology

There are many types of software aimed at DES. Dias et al. (2016) tried to summarized the most used DES software. The list of 19 DES software tools is in Figure 1. SIMPROCESS is one of them (in 2016 it was in the middle of the compared tools – see Figure 1). Although this software is not a new one and is relatively user-friendly, it is still not one of the most used DES products. The name "SIMPROCESS" appears 24 times in WOS papers, 28 times in SCOPUS papers (most are identical to WOS). Most of these papers are aimed at business

process simulation or supply chain management. Only one of the ProQuest 50 papers is connected namely with project management – Kienbaum et al. (2013) proposed a systematic approach for model building and analysis of the product lifecycle processes of complex systems development, products and/or services, making use of Project Management, Business Process Management and Simulation techniques in an integrated and unified way.

DES Tools	WSC	DOCS	REVIEWS	SOCIAL	WWW	Growth	tot. (WSC docs social WWW)	Rank 2016
Arena	10	10	10	10	9	10	9,9	1
ProModel	10	9	9	5	9	5	7,6	2
FlexSim	6	7	7	9	8	6	7,2	3
Simul8	6	7	9	7	6	8	7,23	4
WITNESS	8	8	9	7	8	4	7,2	5
ExtendSim	7	8	8	4	5	5	6,2	6
Simio	6	6	4	5	8	9	6,1	7
Plant Simulation	1	6	7	6	7	8	6,1	8
AnyLogic	8	8	8	2	5	7	5,92	9
SIMPROCESS	9	10	4	1	6	4	5,0	10
AutoMod	9	6	7	1	4	4	4,83	11
Micro Saint	4	5	5	0	10	4	4,8	12
QUEST (Delmia)	3	6	4	3	8	4	4,8	13
Enterprise Dynamics	5	4	7	4	4	6	4,8	14
ProcessModel	4	5	1	4	10	3	4,7	15
SimCAD Pro	3	2	5	3	3	5	3,7	16
GPSS World	7	6	2	0	3	4	3,18	17
SLX + Proof 3D	7	3	3	1	3	3	2,9	18
ShowFlow	3	2	5	0	5	0	2,4	19

Figure 1. Final score of DES tools (Dias et al., 2016)

3.1. SIMPROCESS Description

The simulation software SIMPROCESS was developed by the American firm CACI Products Company (2001). SIMPROCESS is a hierarchical and integrated tool for business process simulation, especially for the Business Process Reengineering and the Information Technology. SIMPROCESS offers 3 instruments for the simulation models: Process Mapping, Discrete Simulation and Activity-Based Costing. Process Mapping is used for visual description of the business processes. Discrete Simulation studies the dynamic behavior of systems through experiments with computer model. The changes in the system are not observed continuously during the discrete simulation, but only when the significant event occurs (start or end of a process, arrival of an entity). The event can occur in any point in continuous time. This type of simulation is useful for modelling various business processes (especially production or inventory ones). Activity-Based Costing is a technique for accumulating cost for a given cost object, i.e. product, customer or process. SIMPROCESS uses various 2D graphic components and animation for a process representation. SIMPROCESS Main components:

- Processes and activities: a process may consist of several interrelated activities that create a new value as output for subsequent processes.
- Resources: objects that are used to model the limited capacities of personnel, materials or production assets that are used in the activities.
- Entities: dynamic objects (customers, products, documents, project) that move through the processes and use various resources.

- Connectors: connect processes and activities and define the direction of movement of the entities.
- Pads: serve for the connectors' line-up to an activity.

3.1. Case Study - Project Description

The purpose of this article is to expand the range of articles focused on the combination of project management and DES using SIMPROCESS software.

Table 1. List of project activities (Košťálová, 2009; own translation)

	Activity	Prev.	Time (days)	Resource
1	project launch and contract signings	-	0.5	Supplier, Customer
2	purchase of materials	1	0.5	Supplier
3	preparation of project documentation	1;2	9	Project Manager
4	initial analysis, preparation of wireframes	1	4	Analyst
5	handover of documents by the customer	1	4	Customer
6	customer's comments on wireframes	4	2	Customer
7	processing of comments	6	2	Analyst
8	written confirmation from the customer	7	0.5	Customer
9	creation of the first graphic design	1	5	Web designer
10	creation of other graphic designs	3;5;8;9	5	Web designer
11	customer's comments on the graphic design	10	2	Customer
12	incorporation of comments	11	2	Web designer
13	confirmation of agreement with graphic designs	12	0.5	Customer
14	creation of the remaining graphic designs	13	10	Web designer
15	customer's comments on the graphic design	14	2	Customer
16	incorporation of comments	15	2	Customer
17	confirmation of agreement with graphic designs	16	0.5	Web designer
18	preparing HTML for flash	12	5	Web develop.
19	convert graphics to flash	14	5	Web designer
20	flash programming	8	25	Flash develop.
21	functionality, quality and completeness testing	17;18;19	3	Project Manager
22	customer's comments on the created part	20;21	1	Customer
23	incorporation of comments	22	2	Flash develop.
24	confirmation of agreement with graphic designs	23	1	Customer
25	trial operation	24	3	Programmer
26	delivery of a list of defects found during the test run	25	1	Customer
27	elimination of defects found during test operation	26	3	Programmer
28	job billing	27	0.5	Supplier
29	handover and acceptance of the work	28	0.5	Supplier, Customer

Project planning, time analysis and simulation model are demonstrated on a real project focused on creating a website for a selected company. The project has 29 activities. List of all activities with their duration (as fixed time), previous activities and resources (people needed for each activity) are in Table 1. The project plan (CPM calculation results) can be made in MS Excel and the Gantt chart can be created based on early start and early finish times of activities (see Figure 2). The length of the project is 49.5 days.

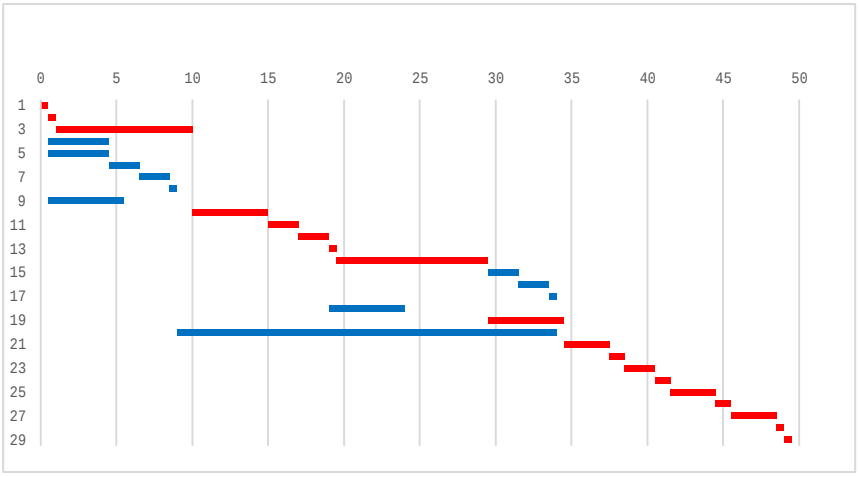

Figure 2. Project Gantt chart in days (Košťálová, 2009)

For the simulation model the times must be stochastic. It is possible to have 3 parameters as in PERT method (optimistic, most expected, pessimistic times) and calculate the results in MS Excel or use Beta distribution and simulate the times and the whole project in SIMPROCESS. The optimistic times were set as 80% of the pre-set times taken now as most expected, and the pessimistic times are equal to 125% of the most expected times. The advantages of the SIMPROCESS usage are also the possibility to incorporate the resources (people) which cannot be analyzed in MS Excel (or Crystal Ball with Monte Carlo simulation).

4. Results

When the project is specified by the list of activities and previous activities, it is possible to create Activity-on-Node (AON) network diagram (see Figure 3) which is useful for the CPM/PERT calculation but it might be also the scheme for the simulation model construction.

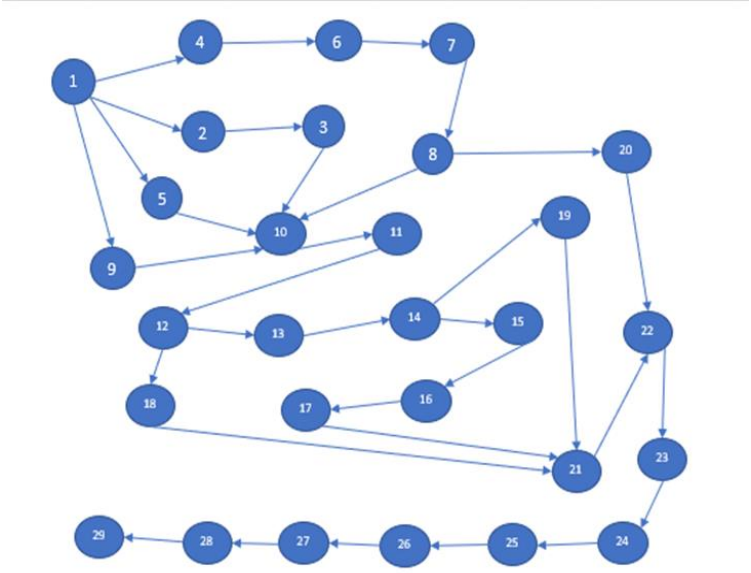

Figure 3. AON diagram (own processing based on Košťálová (2009))

Based on the AON network and 3 times estimations for each activity, which are the parameters of the PertBeta distribution used in SIMPROCESS, the model can be created. The project itself is an entity moving through the model. Since there are several paths and branches in the AON network diagram, it is necessary to define in advance other auxiliary entities as copies of the project, which will pass through parallel paths. A total of 5 entities had to be used (see Figure 4).

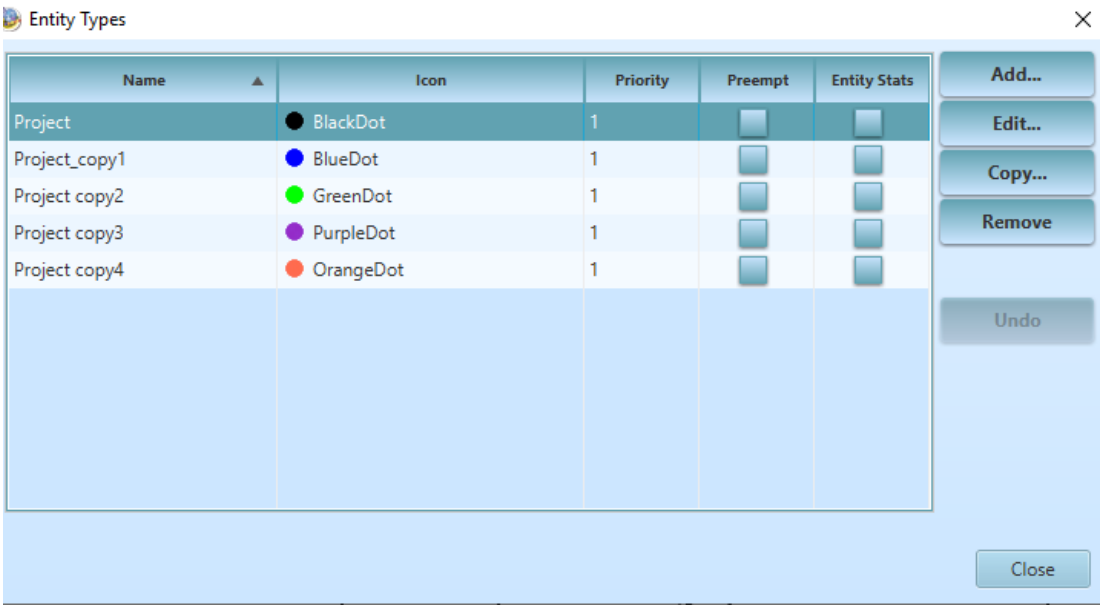

Figure 4. Entity definition in SIMPROCESS

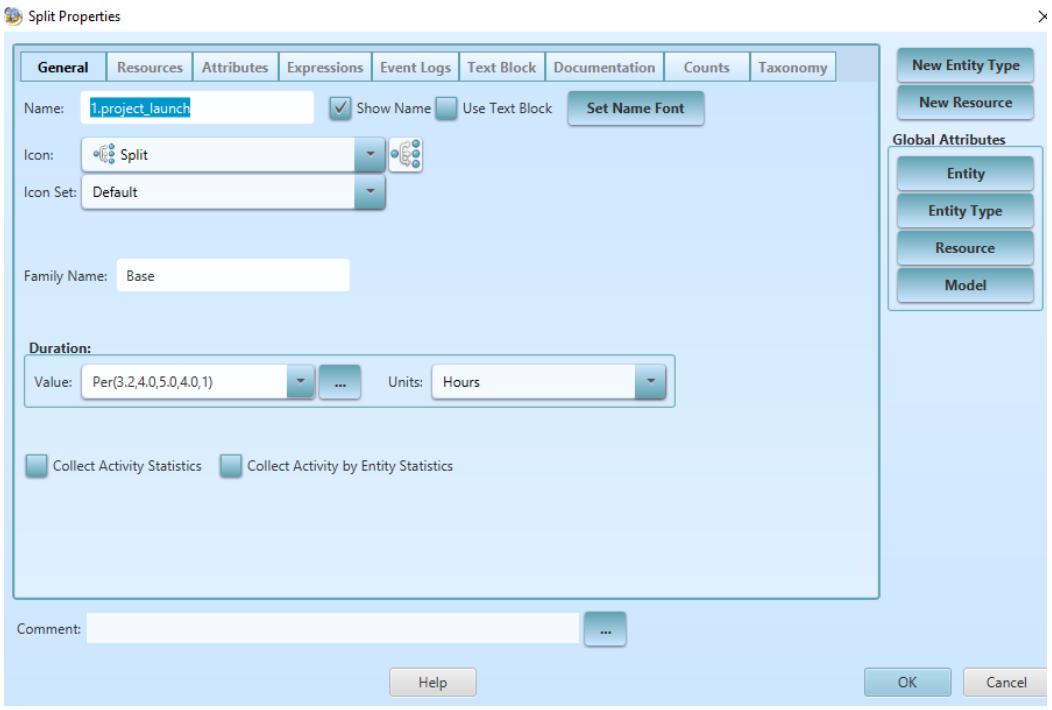

Figure 5. Split properties in SIMPROCESS with PertBeta distribution for activity duration

SIMPROCESS allows to split an entity into multiple clones using the Split activity and later merge everything again using the Join activity and the same Family name (see Figure 5). Finally, all the resources are defined. The whole model is on Figure 6.

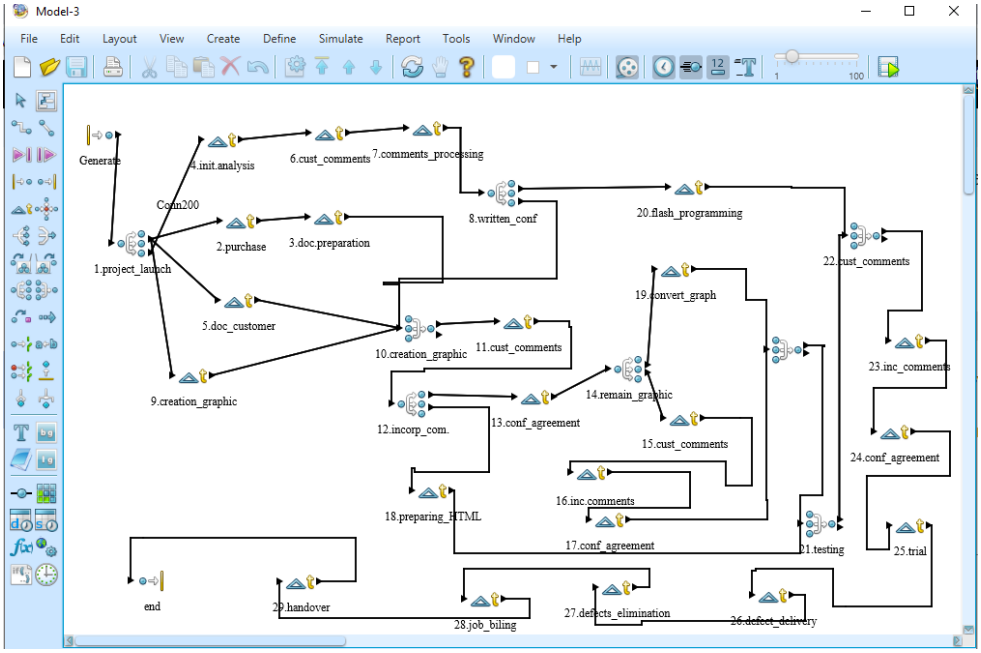

Figure 6. Model of the project in SIMPROCESS

The results of one replication are on Figure 7. They correspond with the results calculated in MS Excel and PERT method where the average time was calculated time as 399 hours, which is nearly 50 working days (when 1 day is equal to 8 working hours). The project time was about 71 days including weekends (see Figure 7, red oval).

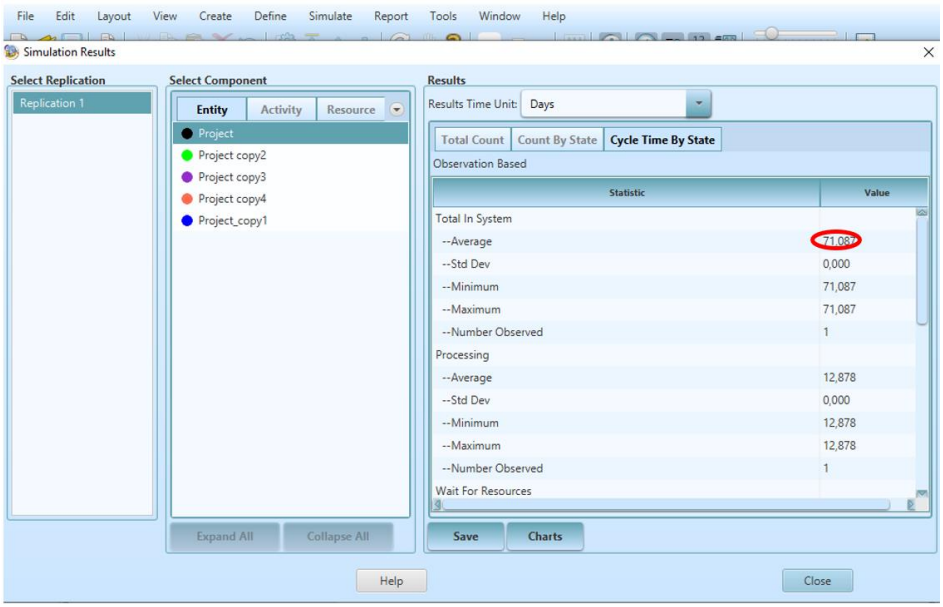

Figure 7. Total project time (red oval), 1 replication

If we include weekends into MS Excel calculations, we have 50 working days + 20 weekend days. Other results showed the workload of individual workers (see Figure 8), the highest utility is about 55% for the flash developer and web designer. SIMPROCESS offers also the Gantt chart visualization – Figure 9 shows first part of the Gantt chart.

Resource : Percent Utilization By State When Available: Replication 1

Resource Names	Idle	Busy	Reserved
Analyst	87,693%	12,307%	0,000%
Customer	65,179%	34,821%	0,000%
Flash developer	44,717%	55,283%	0,000%
Programmer	88,039%	11,961%	0,000%
Proj.Manager	78,144%	21,856%	0,000%
Supplier	95,999%	4,001%	0,000%
Web designer	44,893%	55,107%	0,000%
Web developer	90,225%	9,775%	0,000%

Figure 8. Resource utilization – SIMPROCESS results' list

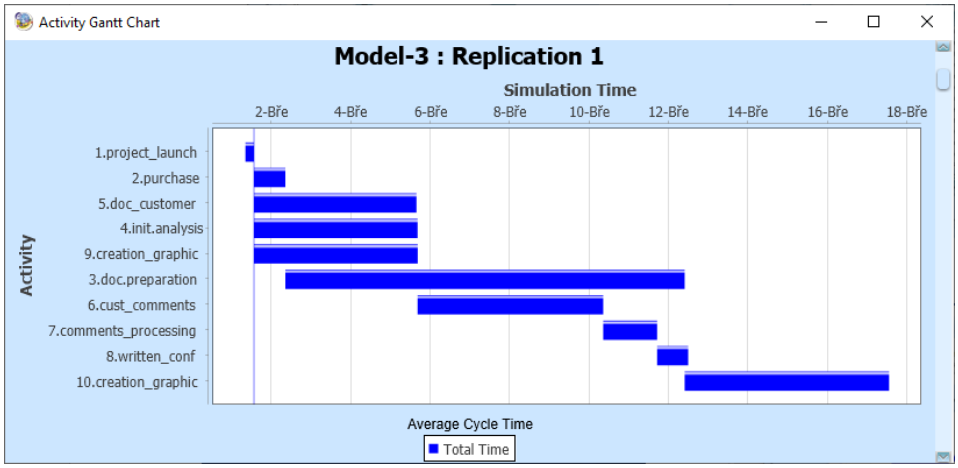

Figure 9. Gant chart taken from SIMPROCESS

Multiple replications can be run to get the average, minimum, and maximum project length – here 100 replications were tested, the results showed that the average project time is around 70 days – 10 weeks, 50 working days, minimum is around 66 days, maximum around 77 days (11 weeks).

4. Discussion

The simulation modeling and project management could be incorporated using a DES simulation software. SIMPROCESS can be one of them. It is easy to operate and it has a tool for the project modeling and Gantt chart specification. The model offers not only the result concerning the project time but also the resources workload and it is possible to incorporate the costs as well. Although the visualization of results is slightly different from the usual in project management software, it is still sufficient for time or cost analysis or project planning. The great advantage of simulations and the use of SIMPROCESS lies primarily in the possibility of setting other probability distributions for generating the durations of individual activities. A suitable extension of the project time analysis is an animation showing the progress of the project supplemented by the display of a specific date and time. Kwak and Ingall (2009) mentioned that simulation is still not a preferred tool in current project

management practice due to its statistical nature, which many project managers are reluctant to address. However, knowledge of simulation modeling and the use of probability distributions to generate activity durations can contribute to better project planning or analysis of time, costs and project risks. Based on the above example, we can agree with the Doloi and Jaafari (2002) statement that DES is a valuable tool to improve the projects' base line value, but, as Kienbaum et al. (2013) mentioned, project management and simulation modeling has been designed with different purposes and knowledge bases in mind, without taking into account their complementary nature, and therefore it is still not common to connect them in real projects. This article tries to show that it is possible and useful. For the future research, cost and/or sensitivity and risk analysis could be also mentioned and incorporated into simulation model. An example of other DES software (such as SIMUL8) would be interesting to compare different approaches of the creation of a project simulation model.

The interconnection of DES and project planning has several limitations. First, the project manager must be able to define not only the duration of each activity, but also the probability distribution for the time generation. Second, it is necessary to create the AON network before the simulation model is built. Third, it is necessary to know the environment of the simulation software and how it works. And finally, the Gantt chart (for example in SIMPROCESS) is the result of one simulation experiment, i.e. it can show an optimistic or, conversely, pessimistic scenario only, not more possible scenarios. It can be shared with other members of the project team only in the form of a fixed image. However, the project simulation model can be useful for deeper what if analysis or time/cost/risk analysis.

5. Conclusions

Project management and simulation modeling has been designed with different purposes. Their interconnection can help the researchers or project managers to better plan or analyze projects not only in terms of the time but also in terms of other resources (human, material, financial). The use of Monte Carlo simulation in project management is quite common, but discrete event simulation and the use of corresponding software offers a further extension of project planning capabilities. SIMPROCESS or similarly oriented software can also be used in project management, especially if variable durations of project activities can be expected. This software can help project managers to better allocate human resources within a project and to analyze the variability of project time and costs. These are the biggest benefits of linking DES and project management.

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Conflict of interest: none.

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Infrastructure, Agricultural Economic Growth and Increase in Farmers' Income: Based on Spatial Heterogeneity and Dynamic Analysis

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Abstract: Infrastructure, as an important social advance capital, is a key guarantee to realize agricultural modernization, promote agricultural economic growth and increase farmers' income. The economic growth effects and income-increasing effects of infrastructure are examined in this study through the analysis of provincial panel data for China from 1997-2018. The findings indicate that: (1) Irrigation and information technology (IT) infrastructure have a significant contribution to agricultural economic growth and increase in farmers' income. (2) Spatial heterogeneity is evident in the economic growth effects and income-increasing effects of infrastructure. The income-increasing effects of irrigation, transportation, agroelectricity, and IT infrastructure have a clear difference in the main cereal-producing, main cereal-marketing, and balanced supply and marketing areas. (3) In terms of promoting economic growth, the elasticity coefficients of irrigation, transportation, and agroelectricity infrastructure change from M-shaped fluctuations to regional stability, while IT infrastructure indicates a change from growth to stability. The elasticity coefficients of all types of infrastructure in terms of increasing farmers' income manifest a change from continuous growth to W-shaped fluctuations.

Keywords: agricultural and rural infrastructure; agricultural economic growth; increase in farmers' income; system GMM Model; bias-corrected LSDV model

JEL Classification: O13; H54

1. Introduction

In early 2020, the eruption of the Covid-19 vaccine pandemic has a profound and widespread impact on the economy around the world. The problem of inadequate infrastructure is further highlighted during the epidemic by the poor quality of agricultural and rural development in China. The report of the 20th National Congress of the Communist Party of China clearly pointed out that rural agriculture should give priority to development so that speeding up the accomplishment of the modernization of rural agriculture. But the main obstacle to developing rural economy is the weakness of infrastructure. At present, the "Top-down" supply decision-making mechanism ignores the actual needs of rural residents for infrastructure, which leads to the coexistence of the insufficiency of the total supply and the excess supply of the rural infrastructure. The unbalance of the supply and demand structure is mainly reflected in the lower comprehensive benefits and efficiency of

infrastructure construction, hindering the rural economic development and the improvement of farmers' living quality. Under the background of agricultural modernization, the improvement of agricultural infrastructure is the basis for the further development of the agricultural economy, and the improvement of rural infrastructure is the key to increasing rural residents' income. Therefore, it is of great significance to scientifically analyze and make up the shortcomings of agricultural and rural infrastructure for agricultural development and promotion of rural revitalization strategy.

The economic growth effect and income-increasing effect of infrastructure have been highlighted in academic attention. Development economists such as Rosenstein-Rodan (1943) first recognized the importance of infrastructure to economic growth. Subsequently, Aschauer (1989) used econometric tools to explore how infrastructure relates to economic growth, and it was expanded by many scholars. From the point of research subjects, technological progress has led to the upgrading of infrastructure. Existing studies mostly use water conservancy irrigation infrastructure (Ye, 2016), rural road infrastructure (Liu & Liu, 2011), agroelectricity infrastructure (Li et al., 2017) as the core variables of infrastructure. With the introduction of new infrastructure, more and more scholars began to bring the digital infrastructure into the scope of research (Min et al., 2020).

Based on the above literatures, studies of the impact of agricultural infrastructure on economic growth and farmers' incomes need to be broadened in the three points below. Firstly, with the vigorous development of digital economy, IT infrastructure should be taken as the core index when selecting research variables. Secondly, most of the previous studies have used methods such as time series data regressions and panel data regressions, ignoring the endogenous issues in the model settings. Thirdly, most studies concentrate on the average effect of infrastructure, which causes the phenomenon that there are limited studies on spatial heterogeneity and dynamic effect. Thus, the estimation of the difference GMM and the system GMM is an attempt to evaluate the impact of agricultural and rural infrastructure on economic growth and farmers' income. Furthermore, the sample is divided into three regions: the main cereal-producing region, the main cereal-selling region, and the balanced supply and marketing region, to examine the heterogeneity. Finally, the dynamic effects of the two effects are examined by means of the nonparametric fixed effects model with time-varying coefficients.

2. Study Design

The research path of this study is to classify infrastructure reasonably based on its definition, then examine the association between infrastructure and agricultural economic growth and farmers' income-increasing through expanding the traditional model from the perspective of spatial heterogeneity and dynamics.

2.1. Classification of Infrastructure

Referring to the definition standards of the World Development Report (1994) and domestic and foreign scholars (Wharton, 1967), infrastructures are divided into two types: agricultural productive infrastructure and rural living infrastructure. Especially, the

information technology infrastructure in the new infrastructure is classified as rural living infrastructure. Specific categories are listed in Table 1.

Table 1. Classification of agricultural infrastructure

Category	Agricultural Producing Infrastructure	Rural Living Infrastructure
Function	To improve agricultural economic development, affect the cross-regional distribution of agricultural products	Increasing the employment of farmers and their income
Specific types	Water conservancy irrigation, transportation infrastructure, fertilizer input, agricultural machinery input	Electricity infrastructure, IT infrastructure, rural education, agricultural research, rural health

2.2. Basic Model

Studies on the relationship between infrastructure and agricultural economic growth and farmers' income-increasing have evolved from neoclassical growth theory (Arrow & Kurz, 1970) to endogenous growth theory (Barro, 1988). Drawing on relevant research, the market function (1) with infrastructure factors is extended to (2):

$$Y_{it} = A_{it} L_{it}^{\alpha} K_{it}^{\beta} G_{it}^{1-\alpha-\beta} \tag{1}$$

where Y_{it} includes two explained variables of agricultural output and rural residents' income, A_{it} is agricultural total factor productivity, L_{it} is agricultural labor force, K_{it} is physical capital stock, G_{it} is infrastructure stock, α and β are coefficients to be estimated, where $\alpha > 0$, $\beta < 1$. In addition, irrigation, transportation, agroelectricity, and IT infrastructure are utilized to represent infrastructure variables, and the model is transformed as follows.

$$Y_{it} = A_{it} L_{it}^{\alpha} K_{it}^{\beta} IR_{it}^{\gamma_1} TR_{it}^{\gamma_2} RE_{it}^{\gamma_3} INF_{it}^{\gamma_4} \tag{2}$$

where IR_{it}, TR_{it}, RE_{it}, INF_{it} are respectively effective irrigation area, gross highway mileage, electricity consumption and average number of mobile subscriptions per 100 households in rural regions. Taking logarithm of both sides of formula (2) and controlling time fixed effect and individual fixed effect, the following equation is obtained.

$$lnY_{it} = \alpha lnL_{it} + \beta lnK_{it} + \gamma_1 lnIR_{it} + \gamma_2 lnTR_{it} + \gamma_3 lnRE_{it} + \gamma_4 lnINF_{it} + \mu_i + \delta_t + \varepsilon_{it} \tag{3}$$

where μ is individual fixed effect, and δ is time fixed effect, ε is a random error term. Additionally, the first-order lag term is added to the equation (3) in order to capture the dynamic effect and mitigate the endogenous effect. The final model as follows:

$$\begin{aligned} lnY_{it} = {} & \theta lnY_{it-1} + \alpha lnL_{it} + \beta lnK_{it} + \gamma_1 lnIR_{it} + \gamma_2 lnTR_{it} \\ & + \gamma_3 lnRE_{it} + \gamma_4 lnINF_{it} + \mu_i + \delta_t + \varepsilon_{it} \end{aligned} \tag{4}$$

2.3. Research Method

In DGMM (Difference GMM) model, the lagged variable is taken as the instrumental variable in the difference equation to eliminate the influence of fixed effect. However, it makes the problem of endogenous interference and dynamic panel bias (Nickell, 1981).

Regarding the method proposed by Blundell and Bond (1998), the estimation method of system GMM is applied to estimate the economic growth effect and income-increasing effect of infrastructure after over-identification test (Sargan test) and interference item serial correlation test (Abond test).

In addition, agricultural production usually manifests strong regional differences (Wu et al., 2015), dividing the sample into main cereal-producing regions, main cereal-selling regions, and balanced production-marketing regions. The bias-corrected LSDV (LSDVC) model is used to investigate the agricultural economic growth effect and the income-increasing effect of infrastructure in each area.

Finally, to further investigate the dynamic effects of infrastructure, this paper introduced a non-parametric fixed effects model with time-varying coefficients by Li et al. (2011) to capture its dynamic process of change.

2.4. Data, Variables, and Statistical Descriptions

The panel data of 31 provinces (municipalities and autonomous regions) in China from 1997 to 2018 were chosen as the initial samples. Hong Kong, Taiwan, and Macao are excluded for missing data. Raw data are collated from China Statistical Yearbook, China Rural Statistical Yearbook, China Agricultural Statistical Yearbook, provincial statistical yearbooks, and bulletins. The specific variables are presented in Table 2 (see below).

- Explanatory variables. The gross output value of agriculture, forestry, animal husbandry, and fishery (GDP_{it}) and per capita disposable income of rural residents (NI_{it}). The base period is taken to be 1997, this study uses the gross output value index for agriculture, forestry, animal husbandry, and fishery and the price index to construct the deflator.
- Core explanatory variables. (1) Irrigation infrastructure (IR). The effective irrigation area is used as the proxy variable (Gao, 2015). (2) Transportation infrastructure (TR). Lacking provincial data on rural roads, the total road mileage is used to measure it. (3) Agroelectricity infrastructure (RE), which is measured by rural electricity consumption. (4) Information technology infrastructure (INF). Considering the availability of data, the average number of mobile subscriptions per 100 households in rural regions is used as the proxy variable.
- Control variables. The sown area of crops ($land$), agricultural labor ($labor$), total power of agricultural machinery (mac), and the amount of agricultural mixed fertilizer applied in terms of pure quantity (fer) are taken as substitute variables to control the input of traditional factors. The proportion of financial support for agriculture (gov) is applied to reflect the government's behaviour. The share of the total imports and exports of agricultural products and the total output value of agriculture, forestry, animal husbandry, and fishery is used for the estimation of the regional agricultural openness ($open$). The disaster rate (dis) is used to estimate climate change, to further measure the significance of the above-mentioned variables for the growth of the agricultural economy and farmers' income-increasing (Reimers & Klasen, 2013).

Table 2. The detailed variable settings

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
$ln\,GDP$	682	6.7249	1.0999	3.7245	8.6322
$ln\,NI$	682	8.2710	0.5630	7.0776	9.6783
$ln\,IR$	682	7.1360	1.0279	4.6975	8.7192
$ln\,TR$	682	1.9664	0.9293	-0.9163	3.5013
$ln\,RE$	682	4.1877	1.6026	-1.7928	7.5669
$ln\,INF$	682	4.3349	1.4944	-1.6094	5.7066
$ln\,land$	682	8.0966	1.1502	4.6424	9.6093
$ln\,labor$	682	6.4555	1.1207	3.6133	8.1786
$ln\,mac$	682	7.3333	1.0970	4.3496	9.4995
$ln\,fer$	682	4.6084	1.2054	0.9163	6.5738
gov	682	26.3077	49.2617	0.4792	518.9401
$open$	682	3.5714	11.7639	0	108.6647
dis	682	25.0933	16.3416	0	93.5900

Firstly, Locally Weighted Scatterplot Smoothing (Lowess) was used to analyze the connection between infrastructure and the growth of the agricultural economy and the income of farmers. The relevant results of irrigation infrastructure are displayed in Figure 1 (Given the space constraint, please contact the author for the Lowess regression chart of the economic growth effect and income-increasing effect of the other three agricultural infrastructures).

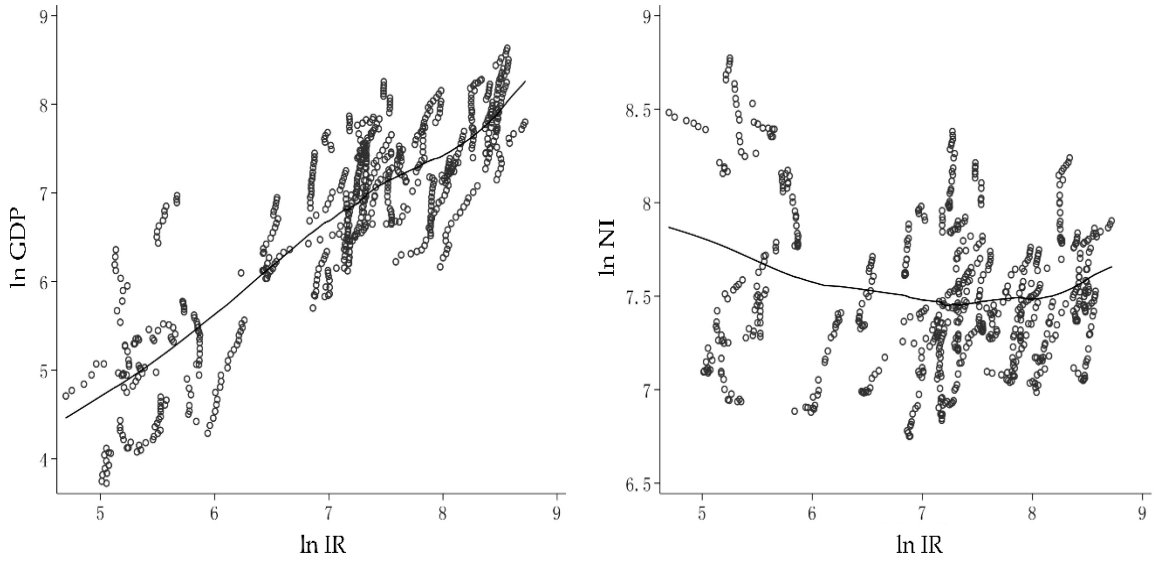

Figure 1. Lowess regression diagram of economic growth effect(left) and income-increasing effect(right) of irrigation infrastructure

Figure 1 indicates that the irrigation, transportation, agroelectricity, and IT infrastructure could promote agricultural economic growth without controlling other variables. The income-increasing effects of agroelectricity infrastructure and IT infrastructure are positive, while those of irrigation infrastructure and transportation infrastructure tend to be stable or even negative.

3. Empirical Results and Analysis

3.1. Baseline Regression Results

Table 3 reveals the economic growth and income-increasing effects of infrastructure. Models (1) and (4) use OLS model to estimate the growth effect of infrastructure on agricultural economy and farmers' income level separately. Among them, the variance inflation factor of Model (4) indicates that there is a serious multicollinearity problem in the model. The variables of $land$, fer, mac, and gov are excluded from the model and then regressed, the results are manifested by Model (5). Model (2) and Model (6) use DGMM (difference GMM) model to evaluate the above two effects. Model (3) and (7) are calculated by the SGMM (system GMM) method.

Table 3. Baseline regression results of economic growth and income-increasing effects

Explanatory Variable	OLS	DGMM	SGMM	OLS	OLS	DGMM	SGMM
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)
$ln\,GDP$		0.4780***	0.6870***				
		(0.0861)	(0.1030)				
$ln\,NI$						0.6390***	0.7040***
						(0.0230)	(0.0284)
$ln\,IR$	0.1010**	0.0812***	0.0685***	0.0066	-0.0295*	0.0826***	-0.0088
	(0.0461)	(0.0242)	(0.0211)	(0.0345)	(0.0163)	(0.0202)	(0.0159)
$ln\,TR$	0.0714**	-0.0033	0.0045	-0.0385*	-0.0398**	0.0088*	-0.0008
	(0.0326)	(0.0045)	(0.0055)	(0.0219)	(0.0194)	(0.0050)	(0.0038)
$ln\,RE$	0.1500***	0.0385***	0.0136	0.1770***	0.1820***	0.0367***	0.0214**
	(0.0131)	(0.0113)	(0.0163)	(0.0082)	(0.0078)	(0.0125)	(0.0092)
$ln\,INF$	0.0595***	0.0162***	0.0150***	0.0369***	0.0349***	0.0108***	0.0163***
	(0.0137)	(0.0036)	(0.0034)	(0.0092)	(0.0076)	(0.0015)	(0.0016)
$open$	-0.0128***	-0.0029***	-0.0005	-0.0007	0.0075***	0.0021**	0.0023**
	(0.0029)	(0.0010)	(0.0015)	(0.0202)	(0.0020)	(0.0008)	(0.0010)
dis	-0.0041***	-0.0006***	-0.0007***	-0.0004	-0.0028***	-0.0000	-0.0002**
	(0.0009)	(0.0001)	(0.0001)	(0.0005)	(0.0006)	(0.0000)	(0.0001)
$ln\,labor$	0.1700***	-0.1460***	-0.0135	0.0085***	-0.1710***	-0.0879***	-0.0151
	(0.0399)	(0.0422)	(0.0212)	(0.0020)	(0.0158)	(0.0279)	(0.0142)
$ln\,mac$	-0.1050***	0.0083	-0.0035	-0.0027***			
	(0.0251)	(0.0086)	(0.0104)	(0.0006)			
gov	-0.0014**	0.0001	-0.0001	-0.1420***			
	(0.0007)	(0.0001)	(0.0002)	(0.0286)			
$ln\,land$	-0.1950***	0.0640***	0.0743**	-0.0628*			
	(0.0442)	(0.0244)	(0.0368)	(0.0345)			
$ln\,fer$	0.6760***	0.0019	-0.0057	0.0057			
	(0.0543)	(0.0203)	(0.0314)	(0.0322)			
constant	3.2970***	1.3190***	-0.0687	8.1330***	8.0770***	1.8310***	1.2430***
	(0.2920)	(0.4380)	(0.1010)	(0.1790)	(0.1010)	(0.2680)	(0.1770)
Regional fixed effect	No	Yes	Yes	No	No	Yes	Yes
Time fixed effect	No	Yes	Yes	No	No	Yes	Yes
AR(1)		-3.1221***	-3.1596***			-5.2272***	-4.9551***
AR(2)		-2.3309**	-0.8001			-5.1101***	-5.0608***
Sargan test		24.8155	23.7108			30.7992	30.8498
Observations	682	589	620	682	682	589	620
R^2	0.941			0.774	0.773		

Note: Standard errors are in brackets; *, ** and *** are significant at levels of 10%, 5%, 1%.

- Overall impact of infrastructure on agricultural economic growth

The result of Model (1) indicates that the coefficients of the core variables are significant. In the estimation of model (4), the coefficients of the other three crucial variables are positive, except for the income-increasing effect of irrigation infrastructure, showing basically that infrastructure plays a beneficial role in the promotion of agricultural economic aggregates. The test results of AR(1) and AR(2) manifest that DGMM and SGMM models cannot reject the null hypothesis. Furthermore, the results of the Sargan tests demonstrate that all of these variables are justified, which could not be rejected at the 10% significance level, indicating that the selected instrumental variables are highly valid. In the result of Model (3), the effect coefficient of the IR on the economic growth in the agricultural sector is clearly positive, manifesting that the irrigation infrastructure could significantly provide a better environment for promoting agricultural economic growth. To be specific, agricultural output will increase by 0.0685% with increasing 1% in effective irrigation area. The economic growth effect of transportation infrastructure is positive but not significant. The possible reason lies in the low construction standard and poor quality of transportation infrastructure especially the rural roads in China. The impact of IT on the economy is observably positive, and the elasticity coefficient of specific substitution variables is 0.015.

- Overall effect of infrastructure on farmers' income increase

The income-increasing effect of water conservancy irrigation and transportation infrastructure shown in model (7) is negative but not significant, the potential reason is that rural residents cannot quickly adapt to advanced agricultural technologies, which brings certain difficulties to increase in income. The income-increasing effect of agroelectricity infrastructure is significantly positive. In particular, other conditions being equal, the income of the rural population will rise by 0.0214% for each additional 1% in rural electricity consumption input. IT infrastructure also plays a significantly positive role in improving the income of rural residents. The continuous improvement of IT infrastructure will cut production and living costs, thereby enhancing farmers' income.

- Effects of controlled variables on economic growth in the agricultural sector and farmers' income increase

The economic growth effect of sown area is evidently positive, probably because it plays a role in rising the gross output value of agriculture, forestry, animal husbandry, and fishery, and then promotes economic growth in the agricultural sector. The rate of disasters acts as a brake on the growth of the agricultural economy and the income of farmers, the feasible reason is that the occurrence of natural disasters will cause damage to agricultural infrastructure and further affect the income of rural residents. The agricultural openness can promote the rise of farmers' income. With the opening of the agricultural market, the agricultural products trading market trend to move toward diversification gradually, as a result, rural residents are increasingly motivated to produce, and then constantly raising their income.

3.2. Heterogeneity Analysis

Referring to the 2001 State Council Opinions on Further Deepening the Reform of the Grain Circulation System, 31 provinces are divided into the main cereal-producing, main cereal-marketing and balanced supply and marketing regions. Kiviet (1995) found that the bias-corrected LSDV (LSDVC) method would be more accurate in showing the growth effect of infrastructure in each producing area.

Table 4. The regression results of three regions

Explanatory variable	Main cereal-producing area		Main cereal-selling area		Balanced Supply and marketing area	
	Model (1)	Model (4)	Model (2)	Model (5)	Model (3)	Model (6)
$ln\,GDP$	1.4590***		1.7730***		1.4650***	
	(0.0001)		(0.0001)		(0.0002)	
$ln\,NI$		0.8590***		0.8060***		0.9410***
		(0.0331)		(0.0439)		(0.0357)
$ln\,IR$	0.0226	0.0122***	0.06750***	0.0233***	0.0051	-0.0126
	(0.0184)	(0.0041)	(0.0156)	(0.0055)	(0.0218)	(0.0099)
$ln\,TR$	0.0079	-0.0027	0.0059	-0.0246***	-0.0145	0.0012
	(0.0054)	(0.0018)	(0.0085)	(0.0075)	(0.0141)	(0.0057)
$ln\,RE$	-0.0629***	0.0031	0.0904***	0.0043	0.0641***	-0.0015
	(0.0126)	(0.0038)	(0.0064)	(0.0029)	(0.0149)	(0.0050)
$ln\,INF$	-0.0087	0.0012	0.1740***	0.0125***	-0.0100*	0.0019
	(0.0061)	(0.0020)	(0.0042)	(0.0047)	(0.0059)	(0.0028)
$open$	-0.0031	-0.0001	0.0008***	0.0003*	-0.0321*	-0.0070
	(0.0067)	(0.0022)	(0.0003)	(0.0002)	(0.0168)	(0.0072)
dis	-0.0008***	0.0001	0.0001	0.0001*	-0.0010***	0.0001
	(0.0001)	(0.0001	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$ln\,labor$	-0.0656***	0.0058	-0.2450***	-0.0116	-0.0839***	0.0026
	(0.0237)	(0.0060)	(0.0093)	(0.0084)	(0.0228)	(0.0101)
$ln\,mac$	0.0033		-0.1240***		-0.0112	
	(0.0090)		(0.0159)		(0.0152)	
gov	0.0026***		0.0010***		0.0004***	
	(0.0007)		(0.0001)		(0.0001)	
$ln\,land$	-0.0772***		0.0877***		-0.0402	
	(0.0241)		(0.0108)		(0.0321)	
$ln\,fer$	-0.0814***		-0.0865***		-0.1100***	
	(0.0215)		(0.0169)		(0.0247)	
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Regional fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observation	273	273	147	147	231	231

Note: (1) The brackets are bootstrapped standard errors; (2) *, ** and *** indicate significance at the levels of 10%, 5% and 1%.

1

- The regional difference of infrastructure economic growth effect

Models (1), (3), and (5) measure the economic growth effect of infrastructure in three regions, respectively. The impact of irrigation infrastructure on economic growth is significantly positive in the main cereal-marketing area, but not significant in the other two areas. At present, the main cereal-marketing area is primarily in the eastern coastal region, which has complete water conservancy irrigation supporting infrastructure. And the main cereal-producing areas ravaged by natural disasters are concentrated in the central and northeast regions, impacting agricultural economic growth inevitably. The irrigation technology and its efficiency in the balanced supply and marketing area are relatively backward compared to the other areas.

The agroelectricity infrastructure has an observably negative impact on economic growth in agricultural sector in the main cereal-producing areas, but has an evidently beneficial impact on the main cereal-selling areas and the supply-marketing balance areas. The reason why there is a phenomenon that the rural electricity supply cost becomes higher and utilization efficiency of agricultural electricity becomes lower is perhaps that the main cereal-producing areas of our country are mainly concentrated in the central hilly areas, which scatters a lot of villages.

The impact of IT infrastructure on the growth of economy is significantly positive in the main cereal-marketing areas, negative in the balanced supply and marketing areas, but not significant in the main cereal-producing areas. The logical reason is that the main cereal-selling areas are mainly clustered around the southeastern coastal regions, with more developed economy and lower cost of information transmission, promoting agricultural economic growth. The impact of transportation infrastructure on agricultural economic growth in each region is not significant similarly.

- The regional difference of infrastructure income-increasing effect

The results of models (2), (4), and (6) illustrate the income-increasing of infrastructure in three regions respectively. The irrigation infrastructure in the main cereal-selling area does not indicate an obvious income-increasing effect. The income-increasing effect of transportation infrastructure in the main cereal-marketing areas is observably negative, while the effect in other areas is not significant. In main cereal-marketing areas, the increasing effect of IT infrastructure is significantly positive, but not significant in other areas.

3.3. Dynamic Analysis of Economic Impact of Infrastructure

Aimed at revealing the dynamic process of economic growth effect and income-increasing effect of various infrastructures intuitively, this paper draws their dynamic effect diagrams as displayed in Figure 2 and Figure 3.

- Dynamic analysis of economic growth effect of infrastructure

The economic growth effect demonstrated by Figure 2 indicates that the elasticity coefficients of irrigation infrastructure fluctuate in an M-shape from 1997 to 2006, and the economic growth effect tends to be stable after 2006. The elasticity coefficients of

transportation and agroelectricity infrastructure also manifest M-shaped fluctuation from 1997 to 2006. The economic growth effect of IT infrastructure illustrates a change from growth to stability, and its elasticity coefficients rise from 0.0004 in 1997 to 0.0254 in 2006. Since then, its elasticity coefficients fluctuate around 0.0280.

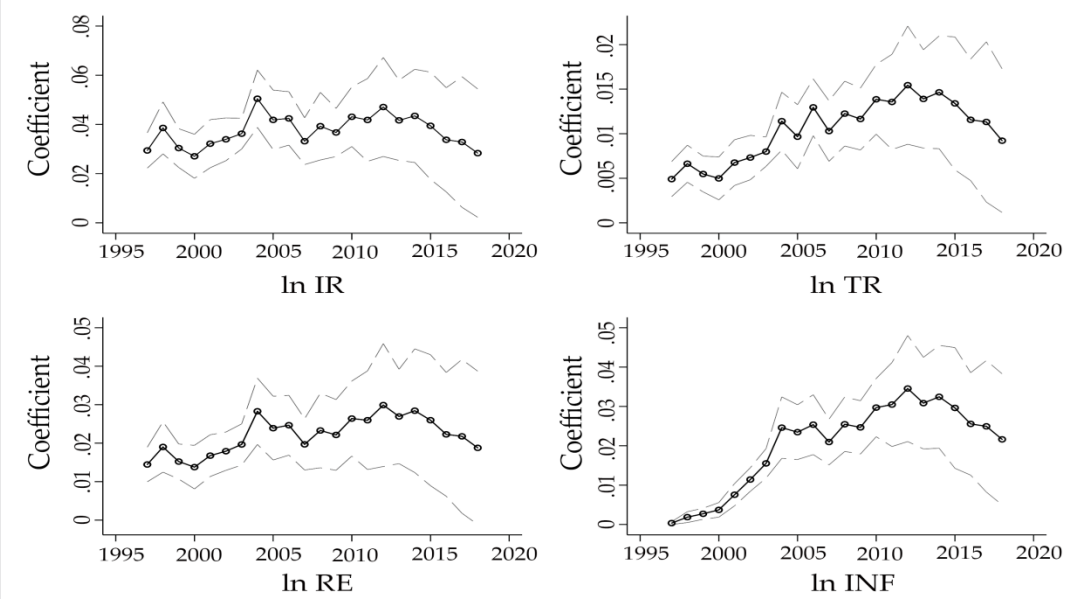

Figure 2. The dynamic effect of infrastructure on agricultural economic growth

- Dynamic analysis of infrastructure income-increasing effect

As can be seen from the income-increasing effect estimated in Figure 3 that the four major infrastructure, especially the IT infrastructure, declares a continuous growth trend from 1997 to 2012. After 2012, the infrastructure has been characterized by W-shaped fluctuations.

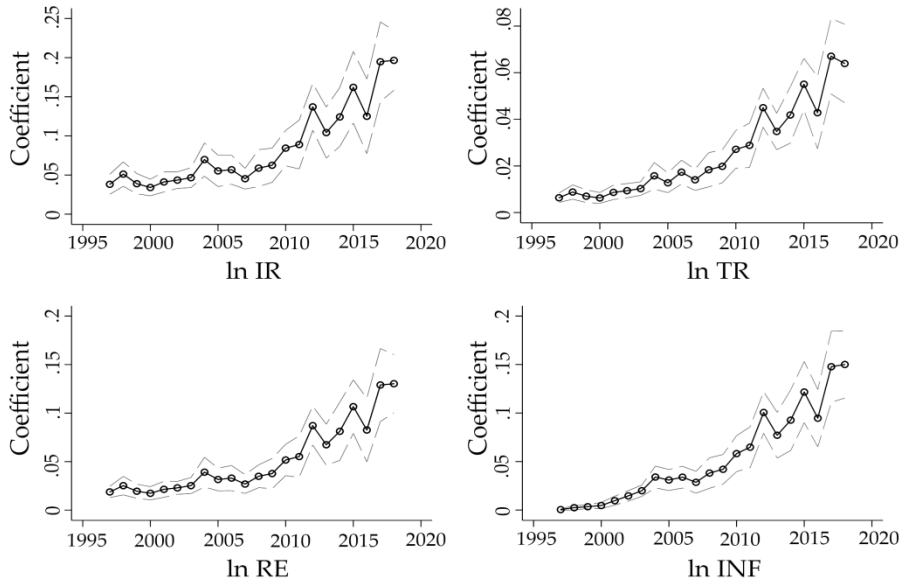

Figure 3. The dynamic effect of infrastructure on farmers' income (the dotted line is the upper and lower bounds of the 95% confidence interval)

4. Conclusions and Policy Recommendations

This study uses the dynamic panel model and non-parametric time-varying coefficient fixed-effect model to test the overall, heterogeneous, and dynamic effects of agricultural infrastructure on economic growth in the agricultural sector and farmers' income increase based on the panel data including 31 provinces in China from 1997 to 2018. The empirical results reveal that: (1) Irrigation and IT infrastructure have a significant promoting effect on agricultural economic growth and increase in farmers' income, and the income-increasing effect of agroelectricity infrastructure is observably positive. (2) The economic growth effect and income-increasing effect of infrastructure indicate spatial heterogeneity. The economic growth effect and income-increasing effect of irrigation infrastructure are positive in principal cereal-producing areas, but not in other areas. (3) From the viewpoint of dynamic effect changes, the elasticity coefficients of the economic growth effect of irrigation, transportation, and agroelectricity infrastructure change from M-shaped fluctuation to regional stability. Concerning the income-increasing effect, the elasticity coefficients of all types of infrastructure manifest a change from continuous growth to W-shaped fluctuations.

Based on the above research conclusions, this paper proposes the following three political recommendations. Firstly, due to the weakness of the actual situation of agricultural infrastructure, it should be changed as soon as possible by establishing and improving the investment and financing system for agricultural infrastructure. Relevant government departments should actively guide financial institutions, private and enterprise capital to jointly build a government-guided diversified investment and financing system. Secondly, government departments should do a good job in farmer training, and thus establish a large professional farmer team to improve the management level and utilization efficiency. Last but not least, it is considered crucial to vigorously develop digital and smart agriculture, and speed up the application and development of digital technologies in agricultural production and rural life.

Conflict of interest: none

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Asymmetric Impact of Economic Policy Uncertainty on Agricultural Prices

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Abstract: From the perspective of asymmetry, this paper uses the relevant monthly data from 2006 to 2021, and analyzes the impact of economic policy uncertainty on the prices of different agricultural products by constructing TVAR model. The empirical results show that: (1) The direction of the impact of economic policy uncertainty on agricultural prices has obvious asymmetry in the low uncertainty zone system and the high uncertainty zone system; (2) For grain and vegetable agricultural prices, the influence degree of high uncertainty zone system is less than that of low uncertainty zone system, while for meat agricultural prices, the influence degree of high uncertainty zone system is greater than that of low uncertainty zone system, that is, there is asymmetry of influence degree. Based on the above conclusions, this paper proposes to formulate differentiated economic policies for different economic states and strengthen the public's policy transmission and guidance of expectations and other policy suggestions.

Keywords: China's economic policy uncertainty; agricultural price; asymmetry; TVAR model

JEL Classification: E31; Q11; Q18

1. Introduction

At the Central Conference on Rural Work in 2021, China proposed to build a "dual circulation" development pattern in which domestic economic cycle plays a leading role while international economic cycle remains its extension and supplement (Xi, 2022), the strategic basis should be placed on expanding domestic demand. The rural areas have a huge space and can do a lot, so we should continue to make it a priority. "People depend on food", as a necessary guarantee of life, there has been a rigid demand for agricultural products. In addition, the proportion of industrial processing demand such as feed use and bioenergy is rising, which makes the correlation between agriculture and other industries improve. Therefore, Therefore, it is important to calm agricultural prices to maintain industrial development and the stability of the whole society.

Economic policy uncertainty means the unpredictable and evaluated economic risks arising from the unknown future development status of economic actors during the process of economic policy change and adjustment (Baker et al., 2016). At present, economic globalization is facing adverse trends, which have exerted a huge impact on the global economy and both show a downward trend. Governments around the world have to take

corresponding measures to contain the economic recession, and have introduced various stimulus policies. Of course, this is not limited to the current special period, such as the European Debt Crisis, Stock Market Crisis and other sudden events will force the government to adjust the policy. As for China, after entering the "new normal" in 2014, the economic growth decelerated and faced with more uncertainties. In order to optimize and upgrade the economic structure, the government frequently adopts a variety of macro policy combinations, such as supply-side structural reform and a series of policies ranging from loose money to prudent money. However, the effects of policy formulation and implementation to need time. Generally speaking, policy delay can be divided into internal delay and external delay. Internal delay refers to the time interval between the occurrence of destabilizing changes in the economy and the decision maker's formulation and implementation of appropriate economic policies. Extrinsic delay refers to the time interval between the implementation of economic policy and the effect of the policy on the economy to achieve the desired target. During this period, due to information asymmetry, the public cannot fully predict the future policy changes of the government, so the continuous changes of policies will greatly increase the level of uncertainty, aggravate the market volatility including agricultural products and increase the risk of macroeconomic operation. In this environment, the study of how economic policy uncertainty affect agricultural prices problem to promote the steady development of national economy has important practical significance.

The innovation of this paper lies in: First, by introducing TVAR model, economic policy uncertainty is divided into high and low degrees, and the difference of its impact on agricultural prices is studied from the perspective of asymmetry. Through empirical investigation, it is discovered that economic policy uncertainty has non-consistency in the direction and degree of impact on agricultural prices. Second, the research conclusions have certain reference value for the government to make policies. This paper further enriched the study on the characteristics of agricultural product price fluctuations, and could more comprehensively grasp the fluctuations of agricultural product prices in different economic environments, providing ideas for the government to reduce the impact of economic policy uncertainty on domestic agricultural product prices.

2. Literature Review

There are abundant researches on the fluctuation of agricultural prices. Most scholars use VAR model and its extended econometric model to analyze the influence degree of a single factor on agricultural prices. Through sorting out, this paper divides the influencing factors into two categories. One is including supply and demand relationship, production cost and other factors of agricultural products market itself. For example, Zhou (2014) believes that the consumption structure of agricultural products has changed rapidly in recent years, from traditional consumption demand to bioenergy demand. Yu (2021) analyzed the influence of various agricultural factor endowments on agricultural prices and found that land factors had the most obvious influence on agricultural products, while capital factors had a lower influence. Tang (2022) found that the circulation system of agricultural products could affect the price of agricultural products through such factors as supply and demand of agricultural

products, market expectations and operating costs. The other is other external factors such as natural disasters, international markets and changes in economic policies. Gu and Fang (2012) found that natural factors can affect the output of agricultural products and thus indirectly change the relationship between supply and demand, among which climate and cultivated land area were the two main influencing factors. Hua et al. (2020) analyzed through FAVAR model that international factors, including food, trade, energy and exchange rate, would also affect domestic food prices. From the perspective of agricultural product industry chain, Tan et al. (2018) argued economic policy uncertainty could affect the price of agricultural products by affecting different links of the vertical industrial chain.

On the uncertainty of economic policy, the existing research mainly focuses on its impact on macroeconomic, business management and financial markets. For example, in terms of macro economy, Baker et al. (2016) built Economic Policy Uncertainty Index based on the frequency of newspaper reports, and found that the index would soar near major struggle events, which provided convenience for later scholars' research, and they concluded that the innovation of policy uncertainty predicted the decline of investment, output and employment. Domestic scholars Jin et al. (2014), Xu and Wang (2019) analyzed the impact of economic policy uncertainty on macro economy through FAVAR model and New Keynesian dynamic general equilibrium model respectively, and found that policy uncertainty was represented by negative demand shock leading to the decline of output, investment and price level. In terms of business operation, the increase of economic policy uncertainty will reduce enterprise investment (Rao & Yue, 2017), inhibiting enterprise innovation (Hao et al., 2016), increasing cash holdings (Li & Shi, 2016), Increase short-term financial assets and restrain corporate financialization (Peng et al., 2018). In financial markets, the uncertainty brought about by the change of economic policies will worsen the market environment and thus increase stock market volatility (Zhou & Jia, 2019) and influence banks' risk taking by changing banks' net liquidity position and credit scale (Hao et al., 2017). In addition, scholars have found that the impact of economic policy uncertainty on other macroeconomic variables is also related to its own degree, that is, the impact of economic policy uncertainty in different states has asymmetry. Van (2016) found that high macroeconomic policy uncertainty made oil prices more sensitive to oil supply and demand shocks, resulting in significant differences in the impact of uncertainty shocks at different levels. Liu et al. (2020) found that when the degree of uncertainty was low, it mainly showed a positive effect, while when the degree of uncertainty was high, it showed a negative effect. Hu and Chen (2020) analyzed the asymmetry of the degree of impact of economic policy uncertainty on housing price and stock market, and found that the degree of influence is greater when the degree of uncertainty is higher.

To sum up, the research perspective of influencing factors of agricultural price fluctuations has been expanding, gradually changing from internal factors related to production, sales and other links to external factors such as international market and macroeconomic policies. Meanwhile, scholars began to use nonlinear research methods to pay attention to the asymmetric effects of economic policy uncertainty impact under different states. Therefore, this paper intends to use TVAR model to study whether China's economic

policy uncertainty under different regional systems will have different effects on agricultural prices in terms of influence degree and direction.

3. Methodology

3.1. Threshold Vector Autoregressive Model (TVAR)

In recent years, nonlinear time series models have attracted wide attention from scholars due to their advantages of asymmetry and periodicity. TVAR model proposed by Tong in 1978 is one of the mainstream models. Based on the traditional VAR model, the nonlinear equation is introduced in this model, and the advantages of the two are combined to describe the asymmetric phenomenon in macroeconomic activities.

The model construction idea is as follows: Firstly, LR nonlinear test method is used to judge if threshold effect exists in the model. Secondly, the optimal threshold value of the model is determined by using grid search method, which allows the variable coefficient to change with the change of the threshold variable. Drawing on the practice of Balke (2000), the search range of the threshold value is set between 15% and 85% quantiles of the sample data. Finally, the optimal threshold was used as the boundary to divide several intervals, and the generalized impulse response was carried out on the research object.

- Principle of model

This paper takes the two-zone TVAR model as an example to introduce its basic principle. The case of the multi-zone system is an extended form of the two-zone TVAR model. The general expression of the model is as follows:

$$y_t = c_1 + A_1 y_t + B_1(L) y_{t-j} + (c_2 + A_2 y_t + B_2(L) y_{t-j})\, I\,(z_{t-d} > \gamma) + \mu_t \quad (1)$$

In Formula (1), y_t is the k×1 dimensional endogenous variable, denoted as ($y_{1t}, y_{2t} \ldots y_{kt}$), c_i, A_i and B_i are respectively the constant variable and the coeval coefficient matrix of zone i, and the coefficient matrix of the lag term of endogenous variable. j is the lag order of the TVAR model. μ_t is a K-dimensional perturbation variable and obeys a normal distribution of mean 0 and variance Σ. $I(\cdot)$ is the indicator function, z_{t-d} is the threshold variable and d is the number of lag periods of the threshold variable. γ is the threshold value, while $z_{t-d} > \gamma$, the indicator function $I(\cdot)=1$, the model expression; While $z_{t-d} \leq \gamma$ indicates that the function $I(\cdot)=0$.

- Nonlinearity Test

The LR test method proposed by Lo and Zivot (2001) was used to test whether there was threshold effect in the TVAR model, and the Bootstrap sampling method was used to repeatedly sample 500 times to determine the threshold number and corresponding threshold value. The original assumption of LR test is that the sample data has linear characteristics, which is suitable for constructing the original linear VAR model. The alternative hypothesis is that the sample data has nonlinear characteristics, which is suitable for constructing the TVAR model based on zoning. The LR test statistic is:

$$LR_{01} = T(\ln(\det \widehat{\sum}_0) - \ln(\det \widehat{\sum}_1)) \quad (2)$$

In Formula (2), $\widehat{\sum}_0$ and $\widehat{\sum}_1$ are covariance matrices of linear VAR model and TVAR model respectively.

- Generalized impulse response

Different from the traditional impulse response function, TVAR model assumes that the variance matrix and covariance matrix are not fixed, and external shocks may cause the transformation of variable relations between regions.

$$GIRF(k,\mu_t,\Omega_{t-1}) = E(y_{t+k}|\mu_t, \Omega_{t-1}-E(y_{t|k}|\Omega_{t-1})) \quad (3)$$

In Formula (3), k is the duration of the impact response, μ_t is the random disturbance term, and Ω_{t-1} indicates the information contained in the system before the exogenous impact occurs at point t. y_{t+k} is endogenous variables, consistent with the endogenous variables involved in Formula (1).

- Model building

Based on the above model introduction, this paper intends to construct the benchmark TVAR model with economic policy uncertainty as the threshold variable, so as to analyze whether there will be heterogeneous effects of different degrees of economic policy uncertainty on agricultural prices. The model is as follows:

$$y_t = c_1 + A_1 y_t + B_1(L)y_{t-j} + (c_2 + A_2 y_t + B_2(L)y_{t-j})I(epu>\gamma) + \mu_t \quad (4)$$

In Formula (4), y_t specifically in this paper includes endogenous variables such as Economic Policy Uncertainty Index, agricultural price index, output growth rate and money supply growth rate. In this paper, epu is selected as the threshold variable, when epu$\leq\gamma$, i=1 indicates the low uncertainty zone system. When epu>γ, i=2 indicates high uncertainty system. Since the main objective of China's macroeconomic policy is to ensure stable economic growth and stable price level, combined with the existing literature, this paper chooses GDP as the control variable. In order to portray the dynamic changes of China's macro economy more completely, this paper further introduces the broad money supply (M_2) to control its influence on output and price level by referring to the practice of Tian and Lin (2016). A reasonable sequence of variables is an important prerequisite for building a good TVAR model. In this paper, the following three benchmark models are constructed: TVAR model {epu, growth, gm_2, gcpi} for grain agricultural products, TVAR model {epu, growth, gm_2, mcpi} for meat agricultural products and TVAR model {epu, growth, gm_2, vcpi} for vegetables agricultural products.

3.2. Variable Selection and Data Sources

Agricultural price variables. The price variable of agricultural products is represented by acpi. In order to better reflect the volatility of the market price of agricultural products, this paper selects the three most common agricultural prices, namely grain consumer price index (gcpi), meat consumer price index (mcpi) and vegetables consumer price index (vcpi).

Economic policy uncertainty variables. Baker et al. (2016) constructed Economic Policy Uncertainty Index by weighted calculation through three categories: news index, tax law

invalidity index and economic forecast difference index. The data source was the South China Morning Post, which has the largest circulation and the largest audience in Hong Kong, and the data information was obtained by screening keywords about the uncertainty of China's economic policy. For detailed construction process, refer to the paper of Baker et al.(2016) and corresponding webpage. The periodic peak of epu is the time when several major economic events occurred. The first time was from 2008 to 2009, Financial Crisis hit the world economy so hard that government had to introduce stimulus economic policies to restore the economy and thus inflationary pressures. The second, in 2011-12, was the domestic fallout of the European Debt Crisis and the leadership transition. In the third, around 2015, growth slowed and volatility in equity and currency markets created more certainty. The fourth was in 2018. The peak was marked by the China-Us trade friction, which had a great impact on China's trade import and export. The fifth was the COVID-19 pandemic in 2020, with epu reaching 935 . Therefore, in the event of uncertainty, the index will reach a high point in a stage, it is highly consistent with the trend of economic development, can accurately quantify the uncertainty in our country, so it is widely used by domestic and foreign scholars.

Macroeconomic variables. Since GDP data only has quarterly accounting and annual accounting but no monthly accounting, data distortion and other problems may occur if low-frequency quarterly data is changed to high-frequency monthly data. Therefore, referring to existing literature, this paper adopts the year-on-year growth rate of industrial added value (growth) instead of GDP to reflect economic output, while the money supply is represented by the year-on-year growth rate of broad money supply (gm2). To avoid seasonal problems, year-on-year figures are used.

Due to massive data required for reasonable estimation of TVAR model, this paper selects the monthly data from 2006 to 2021. The seasonal adjustment method of Census X12 was used to process the epu time series to eliminate the influence of seasonal factors. Secondly, the logarithm of epu, gcpi, mcpi and vcpi is taken to avoid heteroscedasticity problem. In addition to epu derived from the official website of Economic Policy Uncertainty, the three agricultural product price variables, growth and gm_2 all come from the National Bureau of Statistics.

4. Results

4.1. Unit Root Test Results

TVAR model requires all variables to be stationary series, this paper adopts two commonly used methods, ADF test and PP test, to test the stationarity of all economic variables. As shown in Table 1, after first-order difference, all variables are stationary series at the significance level of 1%. To ensure the comparability between the linear model and the nonlinear model, the optimal lag order of the three TVAR models is the same as that of the respective linear VAR models. That is, the optimal lag orders of {epu, growth, gm_2, gcpi}, {epu, growth, gm_2, mcpi} and {epu, growth, gm_2, vcpi} are respectively order 3 lag, order 3 lag and order 2 lag.

Table 1. Stability test results

Variable	ADF test statistics	PP test statistics	Conclusion
epu	-18.314***	-6.285***	smoothly
growth	-4.581***	-4.689***	smoothly
gm_2	-5.412***	-13.560***	smoothly
gcpi	-10.807***	-10.979***	smoothly
mcpi	-4.436***	-7.287***	smoothly
vcpi	-4.369***	-6.814***	smoothly
cpi	-8.377***	-14.853***	smoothly
epi	-8.742***	-8.471***	smoothly
icpi	-8.700***	-8.934***	smoothly

Note: *** represents a significance level of 1%.

Table 2. Results of cointegration test

Model	Null hypothesis	Eigenvalue	Trace statistics	The 5% threshold	P values
Model 1	None	0.100	25.736	15.495	0.001
	At most 1	0.031	5.932	3.841	0.015
Model 2	None	0.068	22.783	15.495	0.003
	At most 1	0.050	9.620	3.841	0.002
Model 3	None	0.184	45.977	15.495	0.000
	At most 1	0.039	7.488	3.841	0.006

Table 3. LR Nonlinear test results

Model	Number of thresholds	LR test statistics	P values	Threshold value
Model 1	1	102.334	0.040**	5.45
	2	209.245	0.004***	
Model 2	1	118.102	0.008***	6.26
	2	202.620	0.020**	
Model 3	1	93.173	0.002***	4.62
	2	147.576	0.010***	

Note: ***, ** and * are significant at the level of 1%, 5% and 10% respectively.

4.2. Cointegration Test

Considering that the use of differential data for empirical analysis is prone to information loss and economic meaning decline of the original data. Therefore, this paper further uses Johansen co-integration test to determine if there is a co-integration relationship between variables in the benchmark TVAR model. If it passes the co-integration test, the original data will be used; if it fails the co-integration test, the first-order difference data will be used. As shown in Table 2, the three benchmark TVAR models all have two co-integration relationships at the 5% confidence level and all pass the co-integration test. Therefore, the original data can be used in this paper for subsequent impulse response analysis.

4.3. Nonlinearity Test

As shown in Table 3, in the three TVAR models, the P values of threshold number 1 and 2 are all less than 0.05, which indicates that the data in this paper are nonlinear.

According to the test results, when the threshold number is 1 and 2 in Model 1, the corresponding significance level is 5% and 1%, respectively, which is more suitable for the two-zone TVAR model. However, when the threshold number is 1 and 2 in model 2 and model 3, the corresponding significance level is 1% and 5% respectively, which is more suitable for the three-zone TVAR model. Therefore, the two-zone TVAR model is selected uniformly in this paper to facilitate comparison. Secondly, the threshold values of economic policy uncertainty are 5.44, 6.26 and 4.62 respectively.

4.4. Impulse Response Analysis

As shown in Figure 1, after estimating the parameters of TVAR model, the prices of grain agricultural products, meat agricultural products and vegetable agricultural products are analyzed respectively under the low uncertainty zone system and the high uncertainty zone system according to the threshold values obtained above. According to the impulse response results of the benchmark TVAR model, whether in the zone system of low

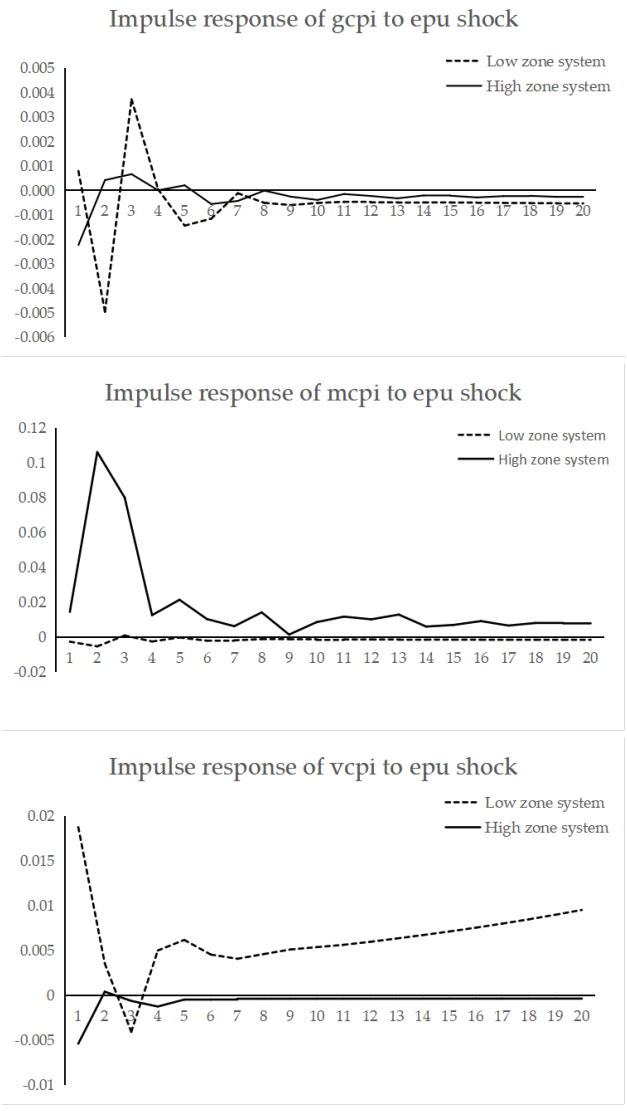

Figure 1. Three kinds of agricultural prices to economic policy uncertainty refers to the impulse response of shocks

uncertainty or in the zone system of high uncertainty, the impact of economic policy uncertainty on the price of agricultural products decreases significantly over time.

In the case of low uncertainty zone and high uncertainty zone, the response direction has obvious asymmetry. First, in the low uncertainty zone system and the high uncertainty zone system, the response direction has obvious asymmetry. Among them, for the price of grain agricultural products, when epu is given a positive impact of one unit standard deviation, the price under both kinds of block system presents an alternating impulse response, but the response direction is different. The first period of low uncertainty block system presents a positive response, while the first period of high uncertainty block system presents a negative response. For the price of meat agricultural products, the price response is mainly negative in the low uncertainty zone system, while it is mainly positive in the high uncertainty zone system. For the price of vegetable agricultural products, the influence direction of economic policy uncertainty on the price is just opposite to that of meat agricultural products, and the response is mainly positive in the low uncertainty zone system, and mainly negative in the high uncertainty zone system.

The reason for this asymmetric effect may be that, in theory, economic policy uncertainty does increase the public's uncertainty about future economic conditions and should indeed dampen agricultural prices from both consumer and producer perspectives. However, according to the impulse response in this paper, whether under the zone system of low uncertainty or high uncertainty, the price of agricultural products will still have positive fluctuations in the next 20 years. There may be two reasons for this: First, as the primary industry, agriculture is an essential consumption in people's daily life. When economic policies are adjusted, market participants may have panic emotions and irrational decision-making behaviors, such as hoarding or dumping, which will lead to price fluctuations. Second, in recent years, with the deepening degree of financialization of agricultural products market, in the economic environment with high uncertainty of economic policies, investors in the futures market of agricultural products, especially grain, take it as an opportunity for investment returns, and there is a certain degree of speculation, which leads to increased demand for financial investment in agricultural products market, especially food products. Therefore, the influence direction of the increase of economic policy uncertainty on the price level of agricultural products is uncertain, that is, the price of grain agricultural products is dominated by negative influence in the low uncertainty zone system and positive influence in the high uncertainty zone system. And the price of meat agricultural products is dominated by positive influence.

Secondly, in the low uncertainty zone system and the high uncertainty zone system, the response degree has obvious asymmetry. Among them, for grain agricultural products and vegetable agricultural products, the impact degree of low uncertainty zone system on their prices is obviously greater than that of high uncertainty zone system. In the low uncertainty zone system, the absolute values of the maximum price response of grain agricultural products and vegetable agricultural products are 0.0053 and 0.019 respectively when facing the positive impact of economic policy uncertainty. However, in the high uncertainty zone system, the absolute value of the maximum response of grain agricultural products and

vegetable agricultural products prices is -0.003 and 0.005 respectively when facing the positive impact of economic policy uncertainty. For meat agricultural products, contrary to the above two types of agricultural products, the absolute value of the maximum response of meat prices is 0.005 in the low uncertainty zone system, while the absolute value of the maximum response is 0.106 in the high uncertainty zone system.

The reason for this asymmetric effect may be the different price transmission mechanism of different kinds of agricultural products. The low uncertainty zone system generally corresponds to the economic boom period, when market participants have a higher understanding of the trading rules and related policy information of the agricultural market, and producers and consumers will make transactions according to their existing psychological cognition. Therefore, sudden changes in economic policies will bring great fluctuations to the agricultural market. On the other hand, the high uncertainty zone system corresponds to the economic depression period. As rational economic man, the market participants have anticipated that the economic environment is unstable, and the degree of price fluctuation will not be too large. For grain and vegetable agricultural products, the measures of "stable production and supply" have been vigorously promoted. China is basically self-sufficient, so the price fluctuation of grain and fresh vegetable agricultural products is greater when the low uncertainty zone system is adopted. The domestic production of meat agricultural products is insufficient, need to import from other countries through international trade channels. Secondly, as the world's second largest economy, when China's economic environment is in the zone system of low uncertainty, the global economic environment is basically in a prosperous period. When our economic environment is in the zone system of high uncertainty, the global economic environment is basically in the downturn period. Xu et al. (2018) found economic policy uncertainty during the period of the high degree of impact on the degree of trade will be significantly higher than the low period, so the price of meat agricultural products fluctuates more in the period of uncertainty.

5. Conclusions and Discussion

Based on an asymmetric perspective, this paper uses Economic Policy Uncertainty Index and the monthly data of agricultural prices in China from January 2006 to December 2021. By constructing the two-zone threshold vector autoregressive (TVAR) model, the asymmetric effects of the uncertainty impact of China's economic policies on the prices of different kinds of agricultural products under different economic conditions of low and high uncertainty degree were studied. The results show that: First, the impulse response directions of economic policy uncertainty impact on agricultural prices are different in the low uncertainty zone system and the high uncertainty zone system. Secondly, the impact degree of economic policy uncertainty impact on agricultural prices has obvious asymmetry in the low uncertainty zone system and the high uncertainty zone system. For grain agricultural products and vegetable agricultural products, the influence degree of low uncertainty zone system is obviously greater than that of high uncertainty zone system. For

meat agricultural products, the influence degree of high uncertainty zone system is obviously greater than that of low uncertainty zone system.

Based on the above research conclusions, this paper puts forward the following policy suggestions: (1) In view of the obvious difference in the impact of economic policy uncertainty on agricultural prices at different levels, we should effectively distinguish different stages of economic policy uncertainty and formulate differentiated policies in different economic states. (2) The price impulse response of different kinds of agricultural products is different, so the specific analysis should be made according to the specific categories of agricultural products in the formulation of policies. (3) Due to the incompleteness of the public's policy information, changes in economic policies will influence their psychological expectations of market participants. Therefore, the transmission of policy information between the government and other economic subjects is particularly important. The government should strengthen the guidance of the public's expectations, increase the public's participation in policy making, and ensure that policy information is as open and transparent as possible.

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Financial Reporting of the Main Electricity Suppliers in the Czech Republic and the Possible Reasons of the Increasing Prices of Energy

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Abstract: In these times of rapidly increasing energy prices many companies and households are questioning why these prices are so high, what are the reasons. The aim of the paper is to investigate the possible reasons of the increased electricity prices based on the reported information in the financial statements of the selected electricity supplier companies in the Czech Republic. Methodology is based on data collection from the relevant legal and other sources and the published annual reports of 7 selected companies. The price of electricity production is based mainly on the price of natural gas, coal and the CO2 emission allowances. The reported reasons for the increase of the prices of these commodities are mainly the EU regulation on CO2 emissions, covid and the energy crisis anticipation related to the war conflict. The prices of electricity for the end customer such as households or industries consists of a regulated component (such as a distribution fee) and an unregulated component (prices from the electricity supplier). The government of the Czech Republic introduced a cap on the unregulated component of the electricity prices for 2023 to help the end customers.

Keywords: electricity supply in the Czech Republic; financial reporting; emission allowances; renewable energy; regulation of electricity prices

JEL Classification: M41; Q40; F64

1. Introduction

In these times of rapidly increasing energy prices many companies and households are questioning why these prices are so high, what are the reasons. First of all, the sources of electricity production should be considered. The main sources of electricity production are fossil fuels such as coal or natural gas, nuclear power and renewables such as wind, biofuels, hydro power, solar energy. The source from which electricity is generated is one of the main factors affecting the cost of producing electricity (Mazegue Pavelková & Živělová, 2016). Table 1 shows the production of electricity by source in the European Union in 2020 (Eurostat, 2020). The main source of electricity production in the EU are fossil fuels and nuclear power although it varies in different member states. Most countries which do not have or use nuclear plants rely more on the fossil fuels or in case of favorable natural conditions on renewable energy sources. Fossil fuels are used the most in Malta, Cyprus and Poland (more than 80%), the least in Sweden (0.5%).

Table 1. Production of electricity by source in EU, 2020, in % (Eurostat, 2021)

Production of electricity by source in EU, 2020	Fossil fuels	Nuclear	Wind	Hydro	Biofuels	Solar	Other
EU average	35.6	24.5	14.3	13.5	5.8	5.2	1.0
Malta	88.7	x	X	X	0.3	11.1	X
Cyprus	87.7	x	5.0	X	13.0	6.1	X
Poland	81.3	x	10.0	1.9	5.3	1.2	0.3
Netherlands	68.4	3.3	12.4	X	7.2	7	1.6
Greece	63.3	x	19.3	7.1	0.9	9.2	0.1
Italy	56.7	x	6.7	17.7	7.0	5.9	3.0
Ireland	56.4	x	35.8	3.8	2.9	0.2	0.9
Estonia	49.9	x	13.9	0.5	30.5	4.0	1.2
Czech Republic	48.6	36.9	0.9	4.2	6.4	2.9	0.1
Germany	42.6	11.2	23.0	4.4	8.9	8.6	1.2
Portugal	39.9	x	23.2	25.7	7.1	3.2	0.9
Bulgaria	39.6	40.8	3.6	8.2	4.2	3.6	X
Hungary	37.3	46.2	1.9	0.7	6.2	7.1	0.7
Latvia	36.3	X	3.1	45.5	15.1	0.1	X
Croatia	35.0	X	12.9	43.4	7.3	0.7	0.7
Romania	34.9	20.5	12.4	28.1	1.0	3.1	X
Lithuania	34.3	X	29.2	20.3	11.2	2.4	2.5
Spain	32.9	22.1	21.4	12.9	2.3	7.9	0.4
Belgium	32.3	38.7	14.4	1.5	5.9	5.7	1.4
Slovenia	28.8	37.0	X	30.4	1.6	2.1	0.1
Slovakia	21.5	53.6	X	16.7	5.8	2.3	0.2
Austria	18.0	X	9.4	62.5	6.3	2.8	1.0
Denmark	15.7	X	56.8	0.1	20.6	4.1	2.7
Finland	13.6	33.9	11.6	23.1	16.8	0.3	0.7
France	8.6	66.5	7.5	12.6	1.6	2.5	0.6
Luxembourg	8.2	X	15.7	49.0	16.7	7.2	3.2
Sweden	0.5	30.0	16.8	44.2	6.8	0.6	0.6

In the Czech Republic, the main source of electricity production is coal and coal products, followed by nuclear power. Table 2 shows the decreasing use of the coal and coal products while the other sources such as nuclear power and natural gas had an increasing trend between 2013 and 2021. The use of renewable sources has shown a promising increase in 2015, however, in recent years the use dropped significantly.

Table 2. Production of electricity by source in the Czech Republic in % (OTE, 2022)

Production of electricity by source in CZ	2013	2015	2019	2020	2021
Coal and coal products	46.82	48.46	49.02	42.66	43.89
Nuclear power	36.67	33.13	39.09	40.75	40.41
Natural gas	8.3	6.41	7.74	9.61	9.89
Renewable sources	5.68	11.77	3.9	6.75	5.56
Other sources	2.53	0.23	0.25	0.23	0.25

Wang (2016) proposes these determinants of electricity price fluctuations: exogenous prices (gas, coal and CO2 prices), internal (consumption and generation) and external (net import between neighbouring bidding zones) electricity flows.

As Eckert and Abnett (2022) and also Zamouřil and Krčál (2022) explained, in the EU energy system, the wholesale electricity price is set by the last power plant needed to meet overall demand. Gas plants often set the price. Long-run dynamics of electricity prices are expected to reflect fuel price developments, since fuels generally account for a large share in the cost of generation (de Menezes et al., 2016). Bojnec and Krizai (2021) states that a competitive and efficient electricity market should balance between suppliers' and consumers' market interests as for industries the electricity prices affect competitiveness and for households' electricity prices affect their welfare.

The European commission's report on European electricity markets (2022) stated, that in Q3 2021, prices of coal and gas have been rising to record levels in the spot market. Spot gas prices averaged 48 €/MWh in Q3 2021, that was 91% higher than the previous quarter (Q2 2021) and represent a 522% increase compared to Q3 2020. During mid-October, price reached almost 100 €/MWh at the TTF hub (European Commission, 2022).

The price of CO2 emission allowances is also a very important factor for the price of electricity. The Emissions Trading System in the European Union was introduced to achieve the climate goal of reducing emissions (Wolff & Feuerriegel, 2019). The European Union Emissions Trading System (EU ETS) is the largest cap-and-trade system in the world. Price instability and allowance oversupply are two characteristics that affect the objectives and the efficiency of this policy (Dimos, 2020). The European commission's report on European electricity markets (2022) stated, that the European market for emission allowances registered important price gains, at the end of September 2021 the closing price was above 64 €/tCO2, in November around 75 €/tCO2 and in December a historical 89 €/tCO2.

2. Methodology

The aim of the paper is to investigate the possible reasons of the increased electricity prices based on the reported information in the financial statements of the selected electricity supplier companies in the Czech Republic. Methodology is based on data collection from the relevant legal and other sources and the published annual reports for the year 2021 of the following selected companies: ČEZ a.s., PRE a.s., E.ON Energie a.s., innogy Energie s.r.o, MND a.s., Centropol Energy a.s., Lama Energy a.s. These companies were selected based on the highest numbers of the points of delivery/transfer (PDT) of electricity to the end customers in 2022. The numbers of PDT are published by the Czech Electricity and gas market operator (Operátor trhu s elektřinou, OTE).

Characteristics of the company focus on the reported information about the ownership structure, profit, operating cash-flow, paid out dividends and on the reported reasons of the rising prices of electricity which is the unregulated part of the price. The price of electricity for end customers include also regulated components which are not reported in the annual reports of the companies and were searched for at the web pages of the regulators of these components which are mainly OTE and ERÚ (the Czech Energy Regulatory Office).

Methods of description and comparison are used. Searching for keywords such as emission allowances or renewable energy were also used in case of the annual reports.

All companies reported the amounts in their financial statements in Czech crowns (CZK). Most companies reported the amounts in thousands, only ČEZ and MND reported in millions. If some specifics or information is not reported directly in the annual reports, the "x" sign is used.

Limitations of the research is its broad range and the limited space for including comparable reported information of the companies from previous years. Limitations also include only a small number of companies therefor statistical evaluation is not possible.

3. Results

3.1. Characteristics of the Monitored Companies, Ownership Structure, Basis of Reporting

The ownership structure of the companies is very complex as most energy companies in Europe co-operate together. There are many intermediary companies between the final owner and the company which are set up mostly to co-ordinate the trading and other activities of the group. The year of foundation of the companies shown in Table 3 is the year when these companies registered in the Commercial Register and this date is reported in their annual reports. However, many of the companies existed even before, most notably ČEZ and PRE. Other companies were known under a different name, for example innogy Energie used to be RWE Energie.

The main electricity supplier in the Czech Republic is ČEZ. The owner of ČEZ is the Czech Republic, represented by the Ministry of Finance of the Czech Republic with nearly 70% ownership. ČEZ, a.s. is the owner of the ČEZ Group. ČEZ shares are traded on the Prague and Warsaw stock exchanges and are included in the PX and WIG-CEE exchange indices (ČEZ annual report, 2021).

The main shareholder in the company PRE is the Capital City of Prague with 51% of ownership through the intermediary company PRE Holdings. However, the controlling owner is indirectly EnBW CEE Germany which is owned by EnBW

MND is owned by KKCG AG and the final beneficiary is reported to be Karel Komárek, one of the most successful businessmen in the Czech Republic.

The number of employees reported vary within the reports, the reason can be the difference between the actual number of employees and the converted number (average recalculated number, required for example by Czech GAAPs). In case of ČEZ, the number of employees is for ČEZ/ČEZ Group.

Suppliers of last resort are energy suppliers which are obligated to take over the end customers in case of a bankruptcy of their original energy supplier. These companies have a distribution network for electricity. In the Czech republic, the electricity suppliers of the last resort are PRE (for the capital city of Prague and vicinity), E.ON Distribution (sister company of E.ON Energy) for the south of the Czech Republic, and ČEZ fort the rest.

The accounting standards used for reporting and preparing the financial statements are shown in Table 4. Differences of the used accounting standards may have an effect on the reported leased assets and related liabilities as according to IFRS the leased assets are reported by the user and in the Czech Republic by the owner. Also, reporting in fair value

Table 3. Basic characteristics of the main electricity suppliers in the Czech Republic (Annual reports of the companies, 2021)

Company name	Founded	Legal form	Owner	Number of employees	Distribution of electricity	Supplier of last resort
ČEZ, a.s.	1992	Joint-stock company	The Czech Republic (69.8%)	5,704/28,000	yes	yes
PRE, a.s.	1994	Joint-stock company	EnBW CEE Germany / Capital City of Prague	1,209/1,500	yes	yes
E.ON Energie, a.s.	2005	Joint-stock company	E.ON SE Germany	248/261	yes*	yes
innogy Energie, s.r.o.	1994	Limited liability company	innogy Česká republika / MVM Energetika HU	248	no	no
MND, a.s.	2008	Joint-stock company	MND Group AG / KKCG AG Switzerland	795	no	no
Centropol Energy, a.s.	2002	Joint-stock company	Aleš Graf	318	no	no
Lama Energy, a.s.	2007	Joint-stock company	Lama Energy Group CZ	79	no	no

Table 4. Financial reporting characteristics of the companies in 2021 (Annual reports of the companies, 2021)

Company name	Accounting standards used	Audited	Income statement	EPS reported
ČEZ, a.s.	IFRS	yes	By nature	yes
PRE, a.s.	IFRS	yes	Mix of nature and function	yes
E.ON Energie, a.s.	CZ GAAP	yes	By nature	no
innogy Energie, s.r.o.	CZ GAAP	yes	By nature	no
MND, a.s.	IFRS	yes	By nature	yes
Centropol Energy, a.s.	CZ GAAP	yes	By nature	no
Lama Energy, a.s.	CZ GAAP	yes	By nature	no

Table 5. Reported amounts in the Statement of financial performance (Income statement) of the companies in 2021 (Annual report of the companies, 2021)

Company name	Profit before tax	Income tax due	Profit after tax	EPS	Comprehensive income, net	Revenues from electricity sale
ČEZ, a.s.	5,728M	1,321M	4,407M	8.2	(57,432) M	
PRE, a.s.	2,529,453	204,473	2,324,980	601	3,789,938	21,469,871
E.ON Energy, a.s.	2,823,256	499,710	2,285,481	x	x	30,146,927
innogy Energie, s.r.o.	1,652,340	317,056	1,336,941	x	x	13,525,933
MND, a.s.	345M	60M	285M	3.66T	356 M	11,158M
Centropol Energy	(447,959)	0	(364,985)	x	x	
Lama Energy, a.s.	(175,329)	(4,888)	(141,250)	x	x	1,273,760

may differ. All the monitored companies were audited. Earnings per share (EPS) is reported only by the companies using IFRS.

According to the annual report of Centropol Energy, the company is part of a consolidated group, but the consolidated financial statements are not published however they are available at the company´s headquarters.

Table 5 shows the profit or loss of the monitored companies. The amounts are reported in CZK thousand (except of ČEZ and MND). The companies which have no international ownership generated loss. It can be concluded that the rising prices of energy commodities hit them harder. ČEZ generated profit, but the comprehensive income is a significant loss due to the changes in fair value of cash-flow hedges.

The companies report the current and deferred income tax. Table 5 shows only the income tax due (current income tax) which has to be paid.

All these companies sell also gas and therefor it was also monitored if the company reports specifically the revenues only from the electricity sale. It can be seen in the annual reports which company is more focused on the electricity and which on gas. E.ON Energy focus on electricity sales while innogy Energie and MND focus more on gas sale. The reason for it is that MND has its own mining of gas and oil. ČEZ reports revenues from the electricity produced (less payments for solar energy) TCZK 444,368.

Table 6. Other reported data of the companies in 2021 (Annual reports of the companies, 2021)

Company name	Operating cash-flow	Paid out dividends	Receivables, net	Liabilities	Equity	Share Capital
ČEZ, a.s.	59,156M	27.963M	136,039M	994,4462M	116,428M	53,799M
PRE, a.s.	3,472,230	1,674,322	4,361,999	13,079,225	15,431,291	3,869,443
E.ON Energy	2,502,292	1,584	33,848,762	26,693,982	9,482,920	1,676,381
innogy Energie, s.r.o	2,082,035	2,068,053	36,641,723	33,437,181	4,204,982	1,031,131
MND a.s.	(1,118)M	x	7,409M	26,504M	6,460M	1,000M
Centropol	463,048	15,000	3,700,087	3,742,613	1,284,338	3,000
Lama Energy	(113,462)	110,000	1,715,283	2,141,893	238,617	20,000

The main receivables ČEZ a.s. has within the group is to the ČEZ Distribuce a.s. and the main payables are to the ČEZ Prodej a.s. Even though MND reported profit, the operating cash-flow needed for financing day to day business activities is negative. Centropol is the opposite case, loss is reported, but the operating cash flow is positive. Lama Energy reported loss and the operating cash-flow is also negative, but there is still reported paid out dividends. All the companies paid out dividends, except for MND. Also E.ON Energy reported paid out royalties in 2021 but not paid out dividends.

3.2. Renewable Energy, CO2 Emissions, Emission Allowances

CO2 emissions are related to the combustion of fossil fuels in electricity and heat generation and transport.

Table 7 shows the reported electricity production and sales, also the CO2 emission if they are reported. The units of measures are not changed, it is used how it was reported in the annual reports such as TWh, MWh, GWh.

Table 7. Reported electricity production, sales, RES and CO2 emissions (Annual report of the companies, 2021)

Company name	Electricity production	Electricity sold	RES or emission free	CO2 emissions
ČEZ, a.s.	56 TWh	26.8 TWh	33 TWh	0.28 CO2/MWhe
PRE, a.s.		6 TWh	34,186 GWh	0
E.ON Energy, a.s.	129 GWh	15 TWh	3.3 TWh	x
innogy Energie, s.r.o.	x	4,032,762 MWh	x	x
MND a.s.		20 TWh	x	x
Centropol Energy	x	1.3 TWh	x	x
Lama Energy, a.s.	x	0.75 TWh	x	x

Considerable amount of own electricity production is reported only by ČEZ. ČEZ operates the 2 nuclear power plants in the Czech Republic: Temelín and Dukovany. The other companies purchase electricity from other companies (mainly from ČEZ or also from partner companies from abroad in case of innogy) to be sold. ČEZ reported a regular bilateral sale of electricity to PRE and E.ON Energy. Most of the companies also generate or purchase electricity generated by renewable sources such as solar energy and other.

Even though PRE owns photovoltaic and wind plants, the amount produced is not separated from the purchased electricity.

ČEZ generated around 60% of its electricity from emission free sources such as from nuclear power (30,730 GWh), hydro (2,488 GWh), photovoltaic (122 GWh) and wind (8 GWh). ČEZ reported the emission allowances in its assets, divided into non-current and current. MND reportedly actively traded in emission allowances, however there are no specifics revealed in the annual report.

3.3. Electricity Prices for End Customers and Government Interventions in the Czech Republic

The electricity price for the end customers (companies or households) comprises of a regulated and unregulated component. The regulated component of the electricity price is related to the transmission and distribution of electricity which is regulated by the Czech Energy Regulatory Office (Energetický regulační úřad, ERÚ) and also involves payments to the Czech Electricity and gas market operator (Operátor trhu s elektřinou, OTE).

End customers cannot change or influence the regulated part of the electricity price. Only the unregulated part of the electricity price can be influenced by the end customer by choosing or changing their energy supplier.

In the Czech Republic, there are 3 main distributors of electricity: ČEZ Distribuce, E-ON Distribuce and PREdistribuce. Distribution fees vary from distributor to distributor. With this, the Energy Regulatory Office (ERÚ) wants to motivate companies to invest in the

Table 8. Components of the electricity price for end customers (ERÚ, OTE, 2022)

Components of Electricity price for end customers	Regulated component	Regulated by	Can the end customer change it?
Transmission and distribution fees	yes	ERÚ	no
Transmission system operator fees	yes	ČEPS	no
Market operator services	yes	OTE	no
Renewable resources buyout support	yes	Act 458/2000	no
Electricity (including the energy tax and collection point payment)	no	x	Yes, by changing the supplier

network development. This fee also includes the payment for the reserved power based on the main circuit breaker. ČEPS (Česká elektroenergetická přenosová soustava) is the transmission system operator (TSO) for electricity supply in the Czech Republic which balances the supply of electricity with demand on a real-time basis and also maintains the transmission infrastructures. Payment for the services of the market operator is a fee for the Czech Electricity and gas market operator (OTE), which organizes the daily electricity market. The renewable resources buyout support is regulated by the Act 458/2000 Coll. which states in its § 25 point 12 that the operator of the distribution system is obliged, if technically possible, to purchase electricity from renewable energy sources. The purchase price is around CZK 12/kWh (output up to 30 kW) for delivery to the distribution network. However, as a government intervention, the end customers do not pay this fee from October 2022 until the end of year 2023.

The unregulated component of the price is the payment to the electricity supplier company. The end customer can influence it by changing a supplier and also by reducing the consumption of electricity.

Government interventions are focused on the help to the end customers. The decree Nr 298/2022 Coll. states the maximum prices for the supply of electricity. This maximum price is CZK 6,050 /MWh (CZK 6.05 / kWh) including VAT for the unregulated component of the price, i.e. without the distribution fees. This cap is valid from 1.1.2023 until 31.12.2023 for households and government or public institutions and specified industries such as health and social care for 100% of their electricity consumption. For other small or medium size companies the cap covers 80% of their consumption. Also, the fixed monthly payment related to the main circuit breaker is set at CZK 157 per month.

Before the price cap, the government granted help to households in its Decree Nr 262/2022 Coll. where households were given a one-time state allowance called “Economical Tariff” (CZK 3,500 or CZK 2,000, based on the households´ distribution rate). This allowance was included in the monthly advanced payments for electricity from 1.10.2022. The planned second economical tariff was cancelled by the Decree Nr 299/2022 Coll. as the government introduced the maximum price caps on the unregulated component of the price instead.

ČEZ a.s. reported the main components influencing the supplier´s price (the unregulated component of the price). The main components listed were the prices of energy commodities,

mainly hard coal and gas, and the price of CO2 emission allowances. ČEZ reported (ČEZ, annual report for year 2021): "*Wholesale electricity prices for 2022 in Germany were around EUR 50/mWh (Cal22) at the beginning of 2021 and had increased to around EUR 70/mWh, the main reason being the gradual increase in the emission allowance price. Natural gas prices have then increased significantly since the summer. This was a key reason why electricity prices increased to a record high of EUR 325/mWh in December and closed at EUR 220 /mWh (Cal22).*" CO2 emission allowance price (EEX – European Energy Exchange) was 80.7 EUR/t in December 2021 (ČEZ annual report, for year 2021). The other companies reported the reasons such as the increased price of energy commodities, covid and also the war conflict only generally without details.

Table 9. Reported reasons of electricity prices increase (Annual report of the companies, 2021)

Company name	Energy commodity prices	Emission allowance prices	Covid	War conflict	Detailed
ČEZ, a.s.	yes	yes	yes	yes	yes
PRE, a.s.	yes	no	yes	yes	no
E.ON Energy, a.s.	yes	no	yes	yes	no
innogy Energie, s.r.o.	yes	no	yes	yes	no
MND a.s.	yes	no	yes	yes	no
Centropol Energy	yes	no	yes	yes	no
Lama Energy, a.s.	yes	no	yes	yes	no

The main reason of the increased energy prices is the rising price of the energy commodities. The rising prices of the emission allowances was specifically reported only by ČEZ, as it is a producer. Other companies are affected by it indirectly by purchasing electricity from the producers. Some of the companies which listed covid generally also stated that it did not affect them. The war conflict was also mentioned as there is a connection to the rising energy commodity prices through the relevance of the last and most expensive power used for electricity production which is natural gas as mentioned in the introduction.

4. Discussion

The electricity supply and related prices are a complex issue and should be considered in the context of the available sources of electricity, the supply and demand of electricity in domestic and international markets, the available distribution network, government regulations and interventions, the owners´ structure of the company and regulated and unregulated components of the price the end customers pay. Financial reporting may depend on the accounting standards used for preparing the financial statements.

All the sources of electricity production listed by Eurostat such as fossil fuels, nuclear, wind, hydro, biofuels, solar, other (see Table 1) are available and used in the Czech Republic (see Table 2).

The electricity distribution network in the Czech Republic is provided mainly by 3 companies: ČEZ (ČEZ distribuce, a.s.), EG.D, a.s. (formerly known as E.ON Distribuce, part of the E.ON ČR group) and PRE (PREdistribuce, a.s). The electricity distribution price is

regulated by the Energy Regulatory Office (ERÚ) in the Czech Republic and is a part of the regulated component of the final price the end customer pays.

All the monitored companies prepare and publish annual reports. Most of the owner relationships are very complex. In some cases, there are intermediary companies which own the companies but they are only focusing on managing the shares and are also fully owned by some other company. It may seem that these intermediate companies are unnecessary and their only reported income is received dividends, on the other hand the controlled companies have to report the advantages and disadvantages of being controlled according to the § 82 of Act No. 90/2012 Coll., on business corporations, in the Czech Republic. All the controlled companies reported only advantages such as the know-how and experience, technology used, synergies and an affiliation to a recognized brand.

In the annual reports, some information is given only for a Group and not for the main subsidiaries. The electricity supply and the sources used (and other information) is often for the group and the name of the company is used interchangeably with the group name.

5. Conclusions

The price of electricity production is based mainly on the price of natural gas, coal and the CO2 emission allowances. The reported reasons for the increase of the prices of these commodities are mainly the EU regulation on CO2 emissions, covid and the energy crisis anticipation related to the war conflict. The prices of electricity for the end customer such as households or industries consists of a regulated component (such as a distribution fee) and an unregulated component (prices from the electricity supplier). The government of the Czech republic introduced a cap on the unregulated component of the electricity prices for 2023 to help the end customers.

Future research will focus on the comparison of electricity pricing and government intervention with other EU countries and also on the investigation of other reasons of the increase in electricity prices for households.

Conflict of interest: none.

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Robo-advisor: A Deep Reinforcement Learning Algorithm with the Risk Tolerance Regularization for Portfolio Management

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Abstract: In recent years, deep reinforcement learning (DRL) is wildly applied to finance field, especially in portfolio management. DRL algorithm combines the perceptual ability of deep learning with the decision-making ability of the reinforcement learning, showing a better performance. However, the existing studies did not take the risk tolerance of the investor into account when managing the portfolio, leading a wild fluctuating return and a large drawdown to investors. Various emergencies have made the economic environment more uncertain, and posed more severe challenges to portfolio management. Considering this, a novel algorithm is proposed, called β-DRL algorithm. It proposes a novel risk-tolerance-related regularization and introduces it into the objective function. In this way, the proposed algorithm takes into account both the dynamic risk of the portfolio and the investor's risk tolerance. Extensive experimental results on Chinese Stock Market fully illustrate the excellence and robustness of the proposed algorithm.

Keywords: deep reinforcement learning; portfolio management; dynamic risk; risk tolerance

JEL Classification: C53; C58

1. Introduction

Portfolio management (PM) is a key part of the quantitative investment field, whose core issue is to balance the relationship between returns and risks, that is, investors can maximize returns within an acceptable risk. Since the financial market is affected by various complicated external factors such as society, politics, economy, and culture, its risks are time-varying. Therefore, how to build a robust investment portfolio strategy is a key issue of financial technology. Due to the characteristics of high dimensionality, high noise, and nonlinearity of financial data, traditional econometric methods have very limited ability to extract information from financial data, and it is difficult to grasp the non-stationary dynamics and complex interactions of financial markets.

Since the AlphaGo (Silver et al., 2016) debate the top professional player Lee Sedol, Deep Reinforcement Learning (DRL) algorithm have received extensive attention from various fields. DRL algorithm is also used in finance, such as, stock trading (Wu et al., 2020), PM (Betancourt et al., 2021), option pricing (Du et al., 2020), etc. There are many researchers proposed a lot of PM strategies using the DRL algorithm. The first PM system (Moody et al., 1998) using recurrent reinforcement learning (RRL) is proposed and used in S&P 500. A QSR system (Gao et al., 2000) was built based on Q-learning, which generates substantial profits

in Forex market. A financial-model-free RL framework (Jiang et al., 2017) was built for cryptocurrency, which combines the Ensemble of Identical Independent Evaluators (EIIE) topology, Portfolio-vector Memory (PVM), a reward function together, and achieves a higher return. An adaptive RRL-PSO portfolio trading system (Almahdi et al., 2019) was proposed by combining particle swarm and RRL, showing a steady profit on S&P100 index stocks. Despite this, fewer researchers consider the dynamic risk tolerance of the investor in the financial market. Besides, different investors have different risk tolerance. Therefore, how to design a robust PM strategy to maximize the return within the risk tolerance of the investor?

This paper aims to build a robust portfolio strategy under the time-varying, dynamic risk. A novel algorithm is proposed for PM, called β-DRL algorithm. Firstly, a risk-related regularization is built by considering both the risk of the portfolio and the risk tolerance of the investor. Then, the regularization is introduced into the objective function. During the trading process, the agent with the improved objective function can find the optimal allocation. Extensive experiments on the Chinese stock market show the β-DRL robo-advisor can yield higher profits with lower risk than the existing state-of-the-art algorithms.

The remainder of this paper is organized as follows. Section 2 describes the Markov process and the proposed DRL algorithm for PM. Section 3 implements many numerical experiments and compares the experimental results of the β-DRL robo-advisor with several existing algorithms in the Chinese Stock Market. Section 4 discusses the limitation of the β-DRL algorithm. Section 5 concludes this paper.

2. Methodology: DRL Algorithm for PM

PM is a process where the investor allocates the fund among several different financial products. Suppose a portfolio contains m risky assets and one risk-free asset, m stocks are used as the risky assets and the remaining cash is used as the risk-free asset. Thus, the aim of PM is to continuously reallocate fund into the $m + 1$ assets in each period in order to maximize the profit.

This part will illustrate how to implement PM using the DRL algorithm, as shown in Figure 1. PM can be regarded as a Markov Process (MDP), expressed as $M = (S, A, P, \gamma, r)$. Here, S is a set of states, A is a set of actions, $P: S \times A \times S \to [0,1]$ is the transition probability distribution, $\gamma \in (0,1]$ is the discount factor and $r: S \times A \to \mathbb{R}$ is the immediate reward after taking an action in a certain state. The agent will interact with the environment using the policy π_θ to get the next action, that is, $a_t = \pi_\theta(s_t)$. During the training, the agent will continuously interact with the financial market, and get a sequence of the trajectory including states, actions and rewards, expressed as $\tau = \{s_1, a_1, s_2, a_2, \dots, s_T, a_T\}$. For any trajectory, the transition probability distribution satisfies the Markov property, that is $p(s_{t+1}|s_1, a_1, \dots, s_t, a_t) = p(s_{t+1}|s_t, a_t)$. Then, the optimal policy $\pi_\theta: S \to A$ can be learned by maximizing the expected cumulative discounted return

$$J(\pi_\theta) = E_{\pi_\theta}[r(s,a)] = E_{\pi_\theta}[r(s, \pi_\theta(s_t))] \quad (1)$$

The following parts will illustrate the action space, state space, and reward function.

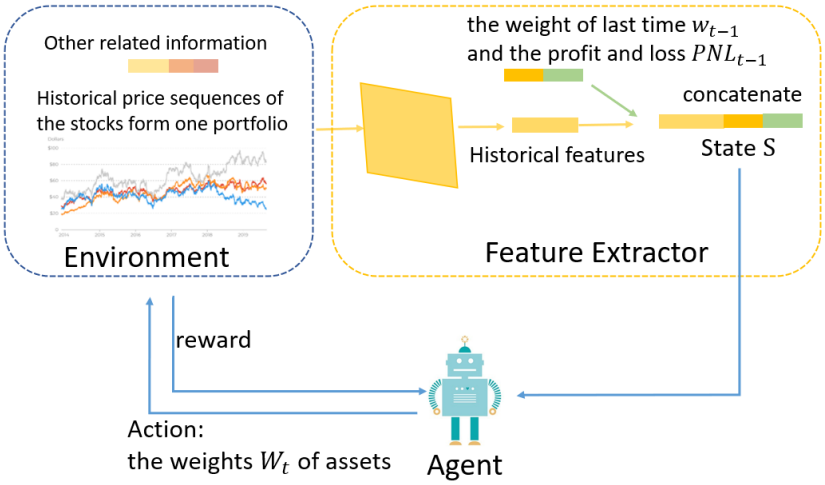

Figure 1. The framework of DRL for PM

2.1. State Space

The state space contains the market information of m stocks, denoted as

$$S_t = \{S_{1,t}, S_{2,t}, \dots, S_{m,t}\} = \{S_{i,t}\}_{i=1}^{m}, \tag{2}$$

where $S_{i,t} = [h_{i,t}, o_{i,t}, l_{i,t}, c_{i,t}, V_{i,t}, MA_{i,t}^{5}, MA_{i,t}^{10}, OBV_{i,t}, MACD_{i,t}, w_{i,t-1}, PNL_{i,t-1}]$ is the state of each stock, including high, open, low, close prices, volume, moving average value of 5 days, and moving average value of 10 days. $w_{i,t-1}$ is the weight of last time, which is used to reduce the trading frequency. $PNL_{i,t-1}$ is the profit and loss at time $t-1$.

2.2. Action Space

The action is the proportion of funds allocated to each asset, represented as

$$W_t = \pi_\theta(S_t) = [w_{1,t}, w_{2,t}, w_{3,t}, \dots, w_{m,t}, w_{m+1,t}], \tag{3}$$

where $w_{i,t}(1 \le i \le m)$ is the weights of m stocks at time t, and $w_{m+1,t}$ is the weight of the remaining cash. And $\sum_{i=1}^{m+1} w_{i,t} = 1$, $0 \le w_{i,t} \le 1$. Besides, the initial weight is $W_0 = [0,0,..,0,1]$, which means the agent only holds cash at the beginning of the investment.

2.3. Reward with the Risk Tolerance Regularizer

Referring to the previous literature (Jiang et al., 2017), the price relative vector is defined as the price change, denoted as

$$y_t = \left(\frac{c_{1,t}}{c_{1,t-1}}, \frac{c_{2,t}}{c_{2,t-1}}, \frac{c_{3,t}}{c_{3,t-1}}, \dots, \frac{c_{m,t}}{c_{m,t-1}}, 1\right) \tag{4}$$

The portfolio value can be represented as

$$P_t = \mu_t P_{t-1} y_t \cdot W_{t-1}, \tag{5}$$

where μ_t is the remainder factor, which means the remainder of the total asset value after deducting commission. $P_0 = 1$. The logarithmic rate of return at time t can be denoted as

$$r_t = \ln \frac{P_t}{P_{t-1}} = \ln(\mu_t y_t \cdot W_{t-1}) \tag{6}$$

The portfolio value reward at the end of the trading period T is

$$P_T = P_{T-1}(\mu_T y_T \cdot W_{T-1}) \tag{7}$$

$$= P_{T-2}(\mu_{T-1}y_{T-1} \cdot W_{T-2})(\mu_T y_T \cdot W_{T-1})$$
$$= \cdots$$
$$= P_0 \prod_{t=1}^{T} \mu_t y_t \cdot W_{t-1} \quad (8)$$

The mean of logarithmic cumulative return R for one episode is

$$R(s_1, a_1, s_2, a_2, \ldots, s_T, a_T) = \frac{1}{T} \ln \frac{P_T}{P_0}$$
$$= \frac{1}{T} \sum_{t=1}^{T} \ln(\mu_t y_t \cdot W_{t-1}) \quad (9)$$

Here, considering the time-varying risk, the objective function is modified by introducing the risk-related restriction into the return function

$$\max_{\theta} R(s_1, a_1, s_2, a_2, \ldots, s_T, a_T) = \max_{\theta} \frac{1}{T} \sum_{t=1}^{T} \ln(\mu_t y_t \cdot W_{t-1}) + \mu(\beta - \sigma_{t-1}) \quad (10)$$

where β is the risk tolerance of the investor, $\sigma_{t-1} = \sigma_{t-1}(r_{t-30}, r_{t-29}, \ldots, r_{t-1})$ is the standard deviation of the immediate returns of the past 30 trading days, and $0 < \mu < 1$ is an adjustment parameter. The larger the β value, the stronger of the investor's risk tolerance.

Therefore, the agent with the novel regularization is called β-DRL algorithm to find a robust PM trading strategy.

3. Experimental Results

In this part, the effectiveness and robustness of the proposed algorithm will be illustrated by implementing several experiments on Chinese Stock Market.

3.1. Dataset and Experimental Setup

The daily data of these stocks is public and can be collected from the online quantitative platform (JoinQuant, 2022), which provides Shanghai and Shenzhen Stock Exchanges from 2005 to the present. Table 1 shows three different portfolios. These stocks of each portfolio belong to the same industry. The training period is set from January, 2005 to December, 2018, and the test period is from January, 2019 to December, 2019. The Deep Deterministic Policy Gradient (DDPG) algorithm is used to train the model. Grid search is used to choose the optimal parameters.

Table 1. Three different portfolios

Portfolios	Stocks	Time period
1	000768, 600038, 600391, 002013, 600316	2015/01/01-2019/12/31
2	002032, 002035, 600690, 000521, 000651	2015/01/01-2019/12/31
3	600036, 600000, 600016, 600015, 000001	2015/01/01-2019/12/31

The initial cash is 1,000,000 RMB. The transaction fees for buying and selling stocks are set according to the real trading. The buying and selling are charged at 0.1% and 0.2% of the amount of the transaction, respectively.

3.2. Evaluation Metrics

The performance of different algorithms is evaluated by the following three metrics.

- Cumulative Rate of Return (CRR): The real return rate of an investment over time. It can be expressed as

$$CRR = \frac{P_T - P_0}{P_0} \times 100\% \tag{11}$$

- Sharpe ratio (SR): The additional amount of return that an investor receives per unit of increase in risk. It is defined as

$$SR = \frac{R_p - R_f}{\sigma_p} \tag{12}$$

where R_p is the asset return, R_f is the risk-free return, σ_p is the standard deviation of the asset excess return. Higher SR means better return under the same risk.

Maximum drawdown (MDD): The measure of the decline from a historical peak during the investment. It represents the risk of the portfolio, and can be represented as

$$MDD = \max_{0 \le t_1 \le t_2 \le T} \frac{R_{t_1} - R_{t_2}}{R_{t_1}} \tag{13}$$

Here, T is the investment period, R_{t_1}, R_{t_2} are the cumulative returns at time t_1 and t_2, respectively.

3.3. Experiment Results

In this part, extensive numerical experiments are performed on the three portfolios to compare the performance of the proposed $\boldsymbol{\beta}$-DRL algorithm with several baseline algorithms, including Robust Median Reversion (RMR) (Huang et al., 2016), On-Line Portfolio Selection with Moving Average Reversion (OLMAR) (Li et al., 2015), Passive Aggressive Mean Reversion (PAMR) (Li et al., 2012), Ensemble of Identical Independent Evaluators with CNN instant (EIIE-CNN) (Jiang et al., 2017) and the naive DRL algorithms. The experimental results of several different algorithms are shown in Table 2.

Table 2. The performance of the proposed algorithm and several existing algorithms

Portfolios	Metrics	RMR	OLMAR	PAMR	EIIE-CNN	Naïve DRL	$\boldsymbol{\beta}$-DRL
1	CRR	28.72%	22.01%	18.26%	35.62%	32.26%	49.75%
	MDD	-13.65%	-21.46%	-30.27%	-12.78%	-14.27%	-7.89%
	SR	0.89	0.78	-0.16	0.89	0.76	1.02
2	CRR	38.65%	42.78%	40.69%	55.36%	45.47%	61.26%
	MDD	-9.86%	-11.39%	-8.14%	-6.39%	-7.63%	-4.75%
	SR	1.16	1.14	1.22	1.48	1.32	1.86
3	CRR	26.32%	27.68%	28.66%	42.46%	38.69%	47.25%
	MDD	-17.65%	-18.96%	-16.62%	-14.69%	-12.68%	-9.65%
	SR	0.98	1.01	1.14	1.20	1.26	1.68

From these results, it's clear that the CRR value of β-DRL algorithm significantly exceeds the other baseline algorithms in the three portfolios. Focusing on the results of Portfolio 1, the CRR of β-DRL algorithm is 49.75%, and higher than other algorithms. At the same time, the MDD value of the β-DRL is -7.89%, which is also obviously lower than others. Moreover, its corresponding SR value is the highest among these algorithms. Similar results

can be seen from the other two portfolios. These results fully illustrate the superiority of the proposed β-DRL algorithm.

Further, the total asset curves of Portfolio 1 are shown in Figure 2 which are implemented by several different algorithms. It is obvious that total asset values of the β-DRL algorithm is higher than other algorithms. Besides, the curve of β-DRL algorithm is relatively steady growth, while the curves other algorithms have relatively large fluctuations. These results further demonstrate the superiority and effectiveness of our proposed β-DRL.

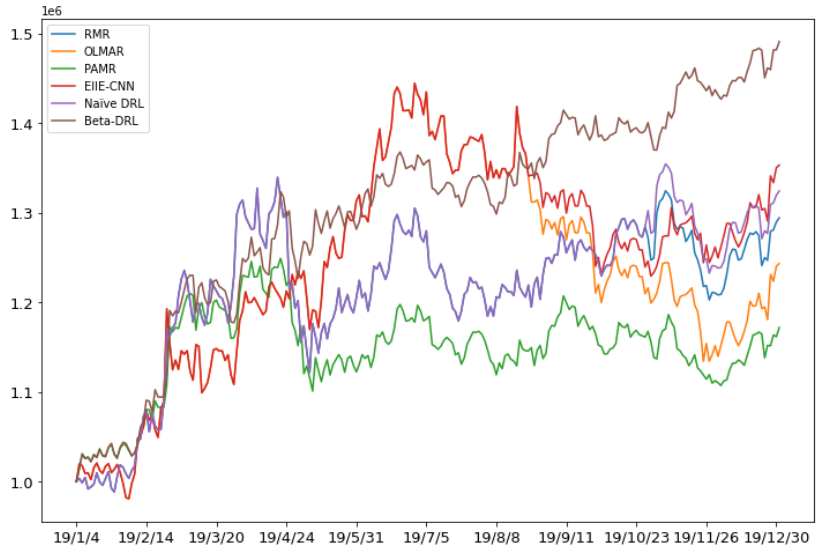

Figure 2. The total asset curve of Portfolio 1. The X-axis represents time, and the Y-axis is the total asset value

4. Discussion

The key of the proposed algorithm is to choose an appropriate value of the risk tolerance β for the investors. A larger value is for the risk appetite; and a smaller value is for risk averse. During the real trading, the risk tolerance of the investors can be assessed through a questionnaire and credit evaluation. Then, the robo-advisor can give a dynamic and profitable portfolio plan. And most of the existing algorithms are tested on American or European Stock Market, but our proposed beta-DRL is more suitable for Chinese Stock Market, and shows a better performance.

It must be emphasized that our proposed algorithm assumes that all orders can be executed at the close price. But in actual transactions, the transaction order may not necessarily be executed at the specified price. It will cause the return of the real trading is worse than the return of the experimental results. But the performance of the proposed algorithm is also better than these several baseline algorithms.

Meanwhile, the proposed algorithm has some limitations. Such as, the risk tolerance of the investors is evaluated by the questionnaire and is set at the beginning the investment. But in real trading, the risk tolerance of the investors is time-varying and will be influenced by the external environment. A dynamic evaluation method for risk tolerance should be studied in the following work. Besides, the proposed β-DRL algorithm can only deal with general unsystematic risks by diversifying the portfolio, and cannot cope with the shocks on the financial market posed by emergencies, such as the COVID-19, extreme weather, war or other

extreme events. These emergencies have posed a severe challenge to PM. Benefited from the development and boom of artificial intelligence, some researchers try to predict these emergencies by collecting and extracting the related or useful information from website, newspaper, twitter, Instagram, etc. In the future work, I will try to combine it with the PM to build a more robust strategy.

Besides, in order to further improve the anti-risk ability of the algorithm, I will consider the risk from the perspectives of systematic risk and unsystematic risk. For the unsystematic risk, researchers or investors typically diversify and lower risk by diversifying the investment or building portfolios. Compared with unsystematic risks, systematic financial risks will cause a macroeconomic downturn and a decline in total output. And the financial and economic crisis caused by the outbreak of systematic financial risks will cause significant losses to the social economy. Thus, I should pay more attention to systematic risk. For systematic risk, people tend to focus monitoring risk and early warning in short-term. But systematic risks take a long time to brew and occur very rarely, leading that short-term monitoring and early warning may be difficult to detect. The outbreak of systematic risk is the process of the system from a normal state to an abnormal state, and a structural break occurs. And even if some changes are detected in advance, the risk has quickly spread to other sectors and caused huge damage to all economic and social system. Thus, studying the mechanism of the systematic risk can help us to understand the system evolution logic before the outbreak of the serious risk, so as to grasp the probability of the key systematic risk and reduce their damage.

5. Conclusions

This paper proposes a novel trading strategy for PM based on the DRL algorithm, named β-DRL algorithm. And the proposed algorithm can not only avoid risks, but also maximize the return within the investor's risk tolerance. Many experimental results fully show the effectiveness and superiority of the β-DRL algorithm on the Chinese Stock Market.

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The Role of Personal Branding and Self-Marketing in Terms of Looking for a Job in Slovakia and Hungary

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Abstract: In the 21st century, self-marketing is an essential tool for job seekers, which can distinguish them from the rest of the candidates. They can easily address the targeted employer and convince the employer that he found the most appropriate candidate for the vacant position. The main objective of our primary research was to map the self-marketing activity of potential job seekers on the Slovak and Hungarian labour markets, and determine whether there are any differences how well-prepared the candidates are on the Slovak and Hungarian labor market in terms of job seeking. The research took place in 2021 and the first half of 2022. The researchers applied an online questionnaire survey. A total of 602 responses were received both for the Slovak and the Hungarian questionnaire. 548 responses could be evaluated from the submitted responses. Microsoft Excel 2016 was used to code the obtained data and prepare diagrams. The hypotheses were tested with the help of IBM SPSS Statistics 25. According to the obtained research results, the Hungarian respondents proved to be professionally more prepared for job interviews than the Slovak job seekers, while the Slovak candidates reached better results in appearance and first impression in the interview process.

Keywords: self-marketing; personal brand; job seeking; labor market

JEL Classification: E24; M30; M31

1. Introduction

In the modern business environment, not only the businesses but the individuals as well have to insist on building the best possible image for themselves (Wziatek-Stasko, 2014). It is essential both in private and professional life. When assessing our own potentials, we have to examine the following three components: self-concept, self-presentation and reflection. The optimal situation is when the mentioned components are balanced. In this case, what the individual thinks about himself/herself and what is presented about himself/ herself is judged similarly by the external environment. In most of the cases we cannot talk about this optimal situation, since difference can be detected between the self-concept and reflection. Self-presentation is where the individual can significantly improve his/her competitiveness as well as has an opportunity to present or change himself/herself in a way that will result in favourable reaction of the environment. It means that certain areas of self-presentation can be shaped. Certain areas might change in long-term, while others change in short-term (Törőcsik, 2017). Not only the private life questions require the balance of self-concept, self-presentation and reflection of the individual, the balance of these components is also crucial

in the world of work. This study is trying to approach this question in terms of the job seeking process.

When applying for a job, the applicant often does not have adequate time to make deep impression. This is the reason why it is important that in addition to professional experience, the personality of the candidate has to be attractive enough to obtain positive feedback on the job interview. This is the point where the personal brand and self-marketing has to be emphasized, which can significantly contribute to tackle obstacles on the labour market and find the appropriate job.

2. Literature Review

Since the late 1990s, self-marketing and personal branding have become increasingly popular topics addressed by self help and personal development books, websites and consulting services. Unfortunately, at the beginning of the 21st century, it had little impact on marketing as discipline and does not matter whether we talk about scientific research or textbooks (Shepherd, 2005). It would be extremely important, since the university degree and the appropriate qualification are not enough to make the individual competitive on the global labour market. It is required from the individuals to obtain the appropriate skills of self-marketing in order to prove that they are the most appropriate candidates for the vacant position (Manai & Holmlund, 2015).

2.1. Personal Branding

According to Ujvári (2019), the personal brand equals to the individual itself. The personal brand of the individual is determined how others feel about the individual. These include both the positive and negative qualities. In terms of marketing, development of self-brand is similar to development of any other brand. According to Shepherd (2005), it is not surprising that the proposed branding and marketing principles for business and products are also recommended for individuals who would like to build and improve their personal brand.

In terms of personal branding, the individuals and their careers can be identified as a brand characterized by performance-related promises, special design and labels (Lair et al., 2005). Building a personal brand is a complex process, which is not exempt from tensions (Fogde, 2011). The personal brand is created by the individual – how others feel about the individual and what impact the individual has on the others. Building personal brand is perceived as an activity about defining and displaying personal strengths and being aware of their impact on the others (Nagy et al., 2018). According to further definition, personal branding is a strategic process of creating and maintaining positive impression based on the combination of unique characteristics, which indicates a certain promise to the target market (e.g. labour market) or target audience through a differentiated communication and established image (Gorbatov et al., 2018). Since personal branding is focusing on preference of selected personal skills and characteristics and surpassing others, the tensions resulting from this fact cannot be avoided. We should think about what happens if someone would like to live and behave as a limited version of herself/himself (Shepherd, 2005). It is important,

that in addition to being marketable, the individual should remain honest. Mentioning the negative qualities on job interviews can prove that the individual is aware of his/her weaknesses and shows willingness to work on his/her personal brand (Fogde, 2011).

When examining the personal brand, it is important to emphasize that the term has different meaning than self-marketing. One of the aims of this study is to define the difference between these concepts.

2.2. Self-Marketing

According to Manai and Holmlund (2015), self-marketing is defined as tool used to communicate the skills of the individual to a wider audience in situations of building networks, including the situation of applying for a workplace positions. According to Shepherd (2005), self-marketing is a variety of activities used by individuals to become known on the market, often with a purpose to be recognized on the labor market and make the process of finding a job easier. Self-marketing has been practiced for several decades in film and pop industry, sports, but the phenomena is becoming increasingly practiced also among the business and political leaders.

Self-marketing and its various aspects have not been thoroughly examined yet. Nevertheless, this study is important in order to understand how graduates are looking for job and prepare for job interviews, how do they obtain and utilize their skills, abilities, knowledge and how they build their personal brand in order to make themselves visible on the labour market. Self-branding as a strategy is becoming more and more important. A brand-centric view of self-marketing skills is one of the possible ways of getting workplace promotion, where the mental health and networking are important issues (Manai & Holmlund, 2015). The field of self-marketing is currently dominated by recruitment specialists, career consultants and self-help gurus. Practical approaches and career-related advice predominate; the comprehensive conceptual framework of self-marketing rooted in the discipline of marketing is not clear; there are only few examples of strategic thinking based on fundamental marketing principles. Both self-marketing and personal branding are dominated by intuitive approaches, while professional advice is often based on unfounded case study experiences. Incorporating these activities into marketing, where the current practices can be appropriately theorized and evaluated, has been an issue for a long time (Shepherd, 2005). Shepherd's ideas described above were born more than 15 years ago. Although the number of scientific research in the field of self-marketing is not adequate, there can be found many valuable results. The framework of self-marketing and the criteria according to which the individuals can be categorized in terms of self-marketing was elaborated.

Manai and Holmlund (2015) developed the new framework for self-marketing skills based both on the existing scientific literature and an empirical research. The model (Table 1) was adapted to the context of job search, but it can be applied in another environment as well. The model consists of three main elements, which differentiate the different aspects of self-marketing: the core of the brand, goals of the brand and the activities of the brand.

Table 1. Self-marketing brand skills (Manai and Holmlund, 2015, p. 17)

SELF-MARKETING BRAND CORE	
Core Identity: Education, skills, personality, values, experience, etc.	
Extended Identity: Characteristics around the core identity such as abilities, cultural aspects, etc.	
Value Proposition: Functional, emotional, self-expressive, and relationship benefits	
SELF-MARKETING BRAND GOALS	
Denting: Presenting oneself in a confident manner and standing out from the competition	
Binding: Team work and the ability to be a functioning and productive member of the team	
Leaning: Exposing oneself to risk and knowing how to profit from this	
Refusing: Showing good and firm character, the courage to refuse an issue that one is against if such an issue comes up	
SELF-MARKETING BRAND ACTIVITIES	
Self-Evaluation: Using introspection, i.e. looking inward; specifically, the act or process of self-examination, or inspection of one's own thoughts and feelings.	Strategy Building: Taking action to achive goals.

Shuker (2010) determined four aspects of self-marketing and classified the individuals into 2-2 groups. The four aspects are the following: engagement (groups: passive and active), focus (groups: internal and external), time (groups: retrospective and prospective) and classification (groups: segregated and integrated).

2.3. Personal Branding and Self-Marketing on the Labor Market

It is positive that the interest in self-marketing and personal brand is increasing, which requires a deeper understanding of building and managing personal brand on the labour market (Gorbatov et al., 2018). Part of the scientific literature is focusing on development of personal brand of the individual on the social networking sites. In the 21st century, it is important both for the researchers and professionals to identify the most appropriate social networking sites that serve the development of personal brand (Hillgren & O'Connor, 2011). These sites are important for the organizations and job advertising agencies to check the candidates and form first impression about the candidate based on the activity provided on social networking site.

In addition to researchers, knowing the opportunities for building personal brand can be useful also for job seekers who are directly affected. Based on the research of Reicher (2018), job seekers are present in large number on LinkedIn, Skype and Viber in addition to the most popular social networking site, the Facebook. Facebook is mainly attracting the secondary school graduates, while LinkedIn those, who completed their university degree. However, it is important to emphasize that LinkedIn is specifically related to the world of work, while Facebook serves more entertainment role. Koprivová and Bauerová (2021) warn the attention to the fact that representatives of Generation Y already like using their smartphones, which is even more characteristic for the representatives of Generation Z. This is the generation is dominating the higher education and self-marketing plays a prominent role in preparing for searching a job.

According to the research results of McCorkle et al., (2003), the female graduates and those close to obtaining their degree are more prepared for looking for a job. The authors also emphasized that those individuals who are reluctant to job hunting and have no clear idea about their career path and what kind of job to choose, they are less prepared for looking for a job. Based on the research results of the mentioned authors, the main objective of this study is to examine whether there is a difference between the job seekers in Hungary and Slovakia in terms how prepared the candidates are to enter the labour market.

3. Methodology

The goal of our primary research was to map the activities related to self-marketing and determine whether there are differences between the jobseekers of Slovakia and Hungary in terms of how prepared they are to enter the labour market and find a job. The survey took place in 2021 and the first half of 2022. We applied a questionnaire survey. Since the pandemic (COVID-19) was an obstacle to in-person interviews, we distributed the questionnaire to the students of our faculty using the mail system of the university and applied the snowball method on social media. We sent our questionnaire to 100 of our friends using the social networking site Facebook, who were asked to send it to 5 more friends after completing it. In addition, we contacted four partner universities of J. Selye University, where the contact persons forwarded the questionnaire to the students. We sent the questionnaire to 100 of our friends using the social networking site Facebook, who were asked to send it to 5 more friends after completing it. Since the questionnaire was sent by e-mail, shared through partner institutions, and published on social media at the same time, and the filling in was completely anonymous, the differences between the people who completed the questionnaire from the three sources cannot be identified.

We prepared a bilingual (Slovak, Hungarian) questionnaire in Google Forms. The questionnaire was divided into four main parts. Respondents had to answer three demographic questions, which focused on gender, age and place of residence. After that, our group of questions examining self-marketing in job interviews assessed the respondents' agreement with the statements we formulated on a five-point Likert scale. The next question focused on what or who they use to prepare for the job interview, followed by a series of Likert-scale statements. This focused on the respondents' appearance at job interviews. Our questionnaire therefore consisted of a total of six questions.

When conducting the research, the main objective was to maintain the balance between the male and female as well as the Hungarian and Slovak respondents (Table 2). The balance in the number of respondents between the countries was met, however, the female respondents dominated the survey in both of the researched countries.

Table 2. Respondents' gender

	Slovakia		Hungary	
	N	%	N	%
Women	175	65.79%	166	58.87%
Men	91	34.21%	116	41.13%
Total	266	100.00%	282	100.00%

The average age of the respondents is 28.9 years (minimum: 18; maximum: 62; standard deviation: 9.77).

We received a total of 602 responses both for the Slovak and Hungarian questionnaires. The responses obtained from the respondents who were already looking for a job were relevant. The questionnaire ends at this stage for those who have never tried looking for a job. A total of 548 questionnaires submitted by the respondents could be evaluated from the total number (602) of obtained questionnaires, mainly because the reason mentioned above. Two hypotheses were formulated before conducting the research:

- H1: In the case of Slovakian and Hungarian respondents, there is a significant difference in how much they agree with the statements related to the job interview.

Since the degree of agreement with the statements can only be examined separately as a hypothesis, we divided the H1 hypothesis into fourteen sub-hypotheses (Table 3):

Table 3. Sub-hypotheses of H1 hypothesis

H1.1:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "I feel confident during in-person communication and making formal phone calls."
H1.2:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "I handle formal correspondence with confidence, I am aware of formal requirements."
H1.3:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "Before a job interview I formulate questions regarding the position I applied for."
H1.4:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "Before the job interview, I check the information about the company activity."
H1.5:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "I feel usually nervous before a job interview."
H1.6:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "I maintain eye contact during the job interview."
H1.7:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "I generally feel fine and relaxed on job interviews."
H1.8:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "I am self-confident on job interviews."
H1.9:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "I am aware of my strengths."
H1.10:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "I find it easy to talk about my positive qualities on a job interview.
H1.11:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "I am aware of my weaknesses."
H1.12:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "I find it easy to talk about my negative qualities on a job interview."
H1.13:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "I feel stressed when one or more people ask questions on a job interview."
H1.14:	There is a significant difference between the respondents' country of residence and the degree of agreement with the statement: "It is stressful when my foreign language skills are tested on a job interview."

Our second hypothesis was the following:

- H2: There is a significant difference both in Slovakia and Hungary what kind of help the respondents use when preparing for a job interview.

The null hypothesis of the H2 alternative hypothesis is that there is no relationship between the variables, so:

- H0: There is no significant difference between the respondents' country of residence and the kind of help they use when preparing for a job interview.

The obtained data was coded and the diagrams were prepared in Microsoft Excel 2016. We used IBM SPSS Statistics 25 program to test the research hypothesis.

4. Results

The research results can be divided into three main parts. At first, the respondents had to decide whether they agree and in what measure with the listed job interview statements. These statements were related to self-marketing of the respondents. In order to compare the responses obtained from the respondents of both countries, we applied mean and standard deviation (Table 4). Agreement with the statements were measured on a 5-point Likert scale (1- do not agree at all, 5 – completely agree).

Table 4. Self-marketing on job interviews – agreement with the statements among the Slovak and Hungarian respondents

	Slovakia		Hungary		Total	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
I feel confident during in-person communication and making formal phone calls.	3.57	1.059	3.96	.980	3.77	1.037
I handle formal correspondence with confidence, I am aware of formal requirements.	3.78	1.027	4.00	.998	3.89	1.017
Before a job interview I formulate questions regarding the position I applied for.	3.52	1.189	3.62	1.123	3.57	1.155
Before the job interview, I check the information about the company activity.	4.18	1.066	4.24	.983	4.21	1.024
I feel usually nervous before a job interview.	3.76	1.258	3.54	1.190	3.64	1.227
I maintain eye contact during the job interview.	3.76	.970	3.94	1.004	3.85	.991
I generally feel fine and relaxed on job interviews.	2.72	1.059	3.00	1.033	2.86	1.054
I am self-confident on job interviews.	3.19	.992	3.60	.947	3.40	.989
I am aware of my strengths.	3.86	1.013	3.98	.935	3.92	.975
I find it easy to talk about my positive qualities on a job interview.	3.47	1.010	3.48	1.084	3.47	1.048
I am aware of my weaknesses.	3.96	.997	4.04	.908	4.00	.952
I find it easy to talk about my negative qualities on a job interview.	3.02	1.017	3.09	1.077	3.05	1.048
I feel stressed when one or more people ask questions on a job interview.	2.89	1.321	2.66	1.279	2.77	1.303
It is stressful when my foreign language skills are tested on a job interview.	3.11	1.258	3.05	1.388	3.08	1.325

Based on the obtained results, it is more characteristic for the Hungarian respondents, that they feel self-confident making formal phone calls, in-person interaction or handling formal correspondence. The Hungarian respondents are more prepared for the job interviews than their Slovak counterparts since they obtained higher average in the research results. They formulate questions to prepare for the job interview and check the activities conducted by the company they apply for. The mentioned factors might cause that the Slovak respondents feel more stressed before a job interview, since a well-prepared candidate for a position can decrease a stress level experienced before and during a job interview. The eye-contact with the interviewer is more frequent in case of the Hungarian respondents, as well as they feel confident and relaxed during the job interview. There is no big difference between the average of the countries (Slovakia, Hungary) in terms that the respondents are aware of their strengths and weaknesses, how easy they find to talk about their positive and negative qualities, however, Hungarians achieved higher average in the mentioned aspects as well. The last two statements were about how stressful the respondents are when they are asked questions from more interviewers or they foreign language skills are tested on the interview. The Slovak respondents achieved higher average in case of these two questions.

In order to determine whether the aforementioned differences were statistically significant, we performed a hypothesis analysis. In our case, the independent variable is the residence of the respondents (Slovakia or Hungary), which is a nominal variable measured on a non-metric scale. The dependent variable is the degree of agreement with the listed statements, measured on a Likert scale. Such variables are identified by Sajtos and Mitev (2007) as scale-type variables measured on a metric scale. If the independent variable is measured on a non-metric scale and the dependent variable is measured on a metric scale, we need to use analysis of variance (ANOVA) during hypothesis analysis. The two assumptions of ANOVA are homogeneity of variance and normal distribution. We tested the variables, and neither of the two conditions were met at the same time, so instead of the analysis of variance, we have to use a non-parametric test, the Wilcoxon test. Due to its length, the analysis is illustrated in two tables, Table 5 and Table 6.

Table 5. Wilcoxon test to test hypothesis H1 – first part

	H1.1: I feel confident during in-person communication and making formal phone calls.	H1.2: I handle formal correspondence with confidence, I am aware of formal requirements.	H1.3: Before a job interview I formulate questions regarding the position I applied for.	H1.4: Before the job interview, I check the information about the company activity.	H1.5: I feel usually nervous before a job interview.	H1.6: I maintain eye contact during the job interview.	H1.7: I generally feel fine and relaxed on job interviews.
Z	-4.293[b]	-2.614[b]	-1.011[b]	-.414[b]	-2.549[c]	-1.500[b]	-3.122[b]
Asymp. Sig. (2-tailed)	.000	.009	.312	.679	.011	.134	.002
a. Wilcoxon Signed Ranks Test							
b. Based on negative ranks.							
c. Based on positive ranks.							

The result of the Wilcoxon test is significant if $p<\alpha$ ($\alpha = 0.05$). From Table 5, we can read that in the case of the first seven statements, there are four statements in which the difference between the residents of the two countries is statistically significant. These are the following: hypothesis H1.1 (I feel confident during in-person communication and making formal phone calls.), hypothesis H1.2 (I handle formal correspondence with confidence, I am aware of formal requirements.), hypothesis H1.5 (I feel usually nervous before a job interview.) and hypothesis H1.7 (I generally feel fine and relaxed on job interviews.).

Table 6. Wilcoxon test to test hypothesis H1 – second part

	H1.8: I am self-confident on job interviews.	H1.9: I am aware of my strengths.	H1.10: I find it easy to talk about my positive qualities on a job interview.	H1.11: I am aware of my weaknesses.	H1.12: I find it easy to talk about my negative qualities on a job interview.	H1.13: I feel stressed when one or more people ask questions on a job interview.	H1.14: It is stressful when my foreign language skills are tested on a job interview.
Z	-4.448[b]	-1.155[b]	-.213[b]	-.765[b]	-.835[b]	-2.348[c]	-.803[c]
Asymp. Sig. (2-tailed)	.000	.248	.831	.445	.404	.019	.422
a. Wilcoxon Signed Ranks Test							
b. Based on negative ranks.							
c. Based on positive ranks.							

Based on Table 6, the results of two additional hypotheses are significant, these are H1.8 (I am self-confident on job interviews.) and H1.13 (I feel stressed when one or more people ask questions on a job interview.).

We were able to accept six of the forteen sub-hypotheses of the H1 hypothesis (H1.1, H1.2, H1.5, H1.7, H1.8 and H1.13), in the case of the rest (H1.3, H1.4, H1.6, H1.9, H1.10, H1.11, H1.12 and H1.14), the null hypothesis was accepted, according to which there is no significant relationship between the investigated variables.

Regarding the job interviews, the respondents were also asked, whether they asked someone for advice on communication and behaviour on job interviews. If this aspect is examined in terms of the individual countries (Figure 1), certain deviations can be detected.

Asking advice from family members, friends and acquaintances was more typical for the Hungarian respondents. 30% of the Slovak respondents ask advice from a person who already works for a company they apply for employment. In the case of Hungarian respondents this ratio was lower. The ratio of those relying on themselves when preparing for job interview was higher among the Slovak respondents. Preparing for job interview with the help of books, journals, newspapers were not typical among the respondents neither in Hungary nor in Slovakia.

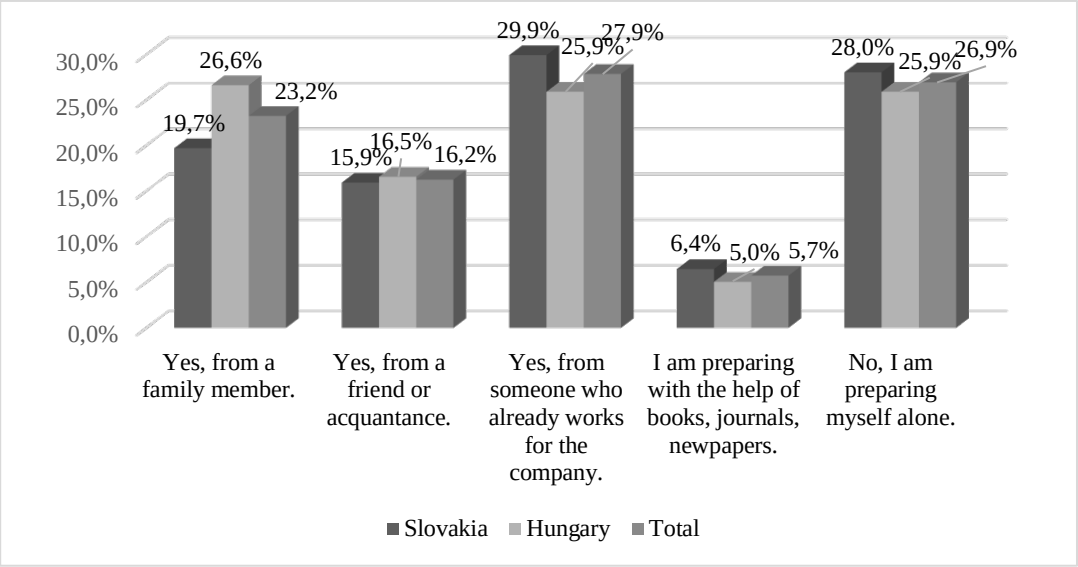

Figure 1. Asking for advice before the job interview among the Slovak and Hungarian respondents

In order to examine whether the differences were significant, we applied a statistical test. Since the independent variable (residence of the respondents) and the dependent variable (advice before the job interview) are both measured on nominal scale, we applied the Chi-square Test (Table 7) to test hypothesis H2.

Table 7. Chi-square Test to test hypothesis H2

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.307[a]	4	.366
Likelihood Ratio	4.324	4	.364
Linear-by-Linear Association	2.465	1	.116
N of Valid Cases	542		
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 15.10.			

Based on the test results, where at the degree of freedom 4 and the significance level is 5%, the deviation between the two variables is not significant ($\chi^2(4) = 4.307$, $p > 0.05$). Hypothesis H0, which states that there is no significant deviation between the variables is approved, while hypothesis H2 was rejected.

In addition to the mentioned statement series, the respondents had to express their opinion regarding further statements (Table 8). These statements were associated with another field of self- marketing, so the focus was put on the appearance of the candidate. We considered it important to deal also with this aspect of self-marketing, since not relevant number of literature sources we found regarding this question. Despite the fact that the skills and competencies of the candidate are crucial to get the job, the first impression about the candidate is determined by the appearance. The level of agreement with the statements was measured on a Liker-scale (1 – absolutely disagree, 5 – maximally agree).

The first statement was a widely used statement also in everyday life. We examined whether the respondents agree with the sentence that „Clothes do not make the man". According to the average, the proportion of those who disagree with the statement was higher in Hungary.

Table 8. Appearance on job interviews – agreement with the statements among the Slovak and Hungarian respondents

	Slovakia		Hungary		Total	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Clothes do not make the man.	2.56	1.288	2.45	1.135	2.50	1.212
I follow the latest fashion trends.	3.04	1.184	2.79	1.086	2.91	1.140
I am aware what patterns and colors to wear.	3.95	.989	3.70	1.156	3.82	1.085
I consciously plan my daily outfit.	3.64	1.094	3.55	1.225	3.59	1.163
I always wear shoes that match my outfit.	3.70	1.160	3.69	1.200	3.69	1.179
I always carry a bag that matches my outfit.	3.30	1.247	3.22	1.286	3.26	1.266
I always take care of my nails.	4.11	1.040	4.33	.898	4.23	.975
I always take care of my hair.	4.23	.898	4.30	.945	4.27	.922
If there is some dirt on my clothes, it does not prevent me of wearing it.	1.85	1.070	1.89	1.149	1.87	1.110
If my shoes are a bit dirty, it does not prevent me of wearing them.	2.24	1.185	2.26	1.215	2.25	1.199

Following the latest fashion trends was more characteristic for the Slovak respondents, however the average barely exceeded the value 3, which means both agreement and disagreement with the statement. The Slovak respondents proved to be more aware what kind of patterns and colours to wear, and it is also more characteristic for them that they consciously plan their daily outfit. Wearing the shoes matching an outfit and choosing a bag to outfit is rather characteristic for the Slovak respondents. Neat nails and hairstyle were characteristic for the respondents of both countries; however, the ratio was a bit higher with the Hungarian respondents. The last two questions examined whether the respondents feel disturbed by wearing shoes or clothes a bit dirty. A bit dirty shoes and clothes were unacceptable for the respondents from both countries, however in both cases the Slovak respondents were close to absolute disagreement with this statement.

5. Discussion

The results of our primary research focused on two fields of self-marketing. The first series of statements (Table 4) focused on the extent the participants in the research prepare for the job interview, how do they feel, how disturbed they get by certain phenomena.

During the testing of the H1 hypothesis, we performed the Wilcoxon test for fourteen sub-hypotheses. The test result was significant in six cases (H1.1, H1.2, H1.5, H1.7, H1.8 and H1.13). According to the means and the results of the hypothesis test, Hungarian respondents are more confident during personal communication and telephone conversations, as well as during written communication. Slovakian respondents are more nervous before a job interview and are more bothered by being asked questions by several people at the same time. To a greater extent, Hungarians feel fine, relaxed and confident during the job interview. These results all support the fact that it would be beneficial in Slovakia to put more emphasis on the education of younger generation (high school students, university students) about the world of work and job interviews, as we can see that more prepared candidates are self-confident and feel relaxed on job interviews. Courses strengthening self-marketing skills

appeared at universities abroad in the previous millennium. Useful theoretical background in the field self-marketing plan was introduced by McCorkle et al. (1992), which is based on the marketing plan model of Kotler (1998), consisting of the following components: situation analysis, self-marketing objectives, objective and positioning strategies, marketing mix strategies, assessment and monitoring. Although the draft has existed for 30 years, based on the research of Manai and Holmlund (2015), the university students miss the courses aimed at self-marketing. Significant differences were detected among the students since some of them made themselves attractive with the help of video CVs and PowerPoint presentations, while others felt themselves lost in this field, as they were not aware of innovative technologies, and could not make themselves attractive on the labour market. It is also worth teaching the students about such "small things" as how it has a positive effect if they approach the job interview with a good mood, courage and self-confidence. Ruben et al. (2015) point out that the research of several authors (e.g., Abel & Deitz, 2008; DeGroot & Motowidlo, 1999; Imada & Hakel, 1977) has already proven that that immediacy behaviour is related to positive job interview outcomes.

When testing Hypothesis H2, we came to conclusion that there is no significant difference based on the respondents' place of residence in terms what kind of help they ask for when preparing for a job interview. According to Figure 1, the Slovak respondents ask help from those working for the company the vacant position is advertised or they simply prepare themselves for the job interview. The Hungarian respondents ask help from their family members in preparation. The research of Schudlik et al. (2020) also points to the importance of proper preparation for a job interview. According to research results, more than two-thirds (67.7%) of their respondents prepare for job interviews with conversations, 43.8% with various online videos, and 32.5% with the help of relatives and friends. Categories considered as professional preparation were used by 20.4% of the individuals. It is important to point out that the preliminary preparation for the job interview is not a negligible activity if the applicant is really committed to getting the job. Caldwell and Burger (1998) emphasize that, although the applicant's personality is of great importance, conscious preparation during studies, building an impressive resume and seeking out information about the given organization are also important for getting the job.

The second series of statements focused on other aspect of self-marketing, the appearance. The results show that the Slovak respondents follow fashion trends to a greater extent the Hungarian respondents, and are aware what to wear on job interviews. Johnson and Roach-Higgins (1987) described that already in the last century, several researches (Kelley et al., 1974; Kelley et al., 1976) proved that in order to achieve a good first impression, the right clothing is very important in job interviews. Recruiters may assume that an applicant who is not aware of dress codes will also make mistakes in professional situations. According to Rucker et al. (1981) the most appropriate outfit on job interviews is generally the form-fitting multi-layered outfit and the least appropriate outfit is generally the loose-fitting single-layered outfit. In certain cases, appearance may be a critical factor. One such situation is when the interviewer has little or no information about the applicant's abilities,

motivation and experience. The other case is when the interviewer has to choose from applicants who have very similar abilities, motivation and experience.

Examining the two series of statements, we can conclude that the Hungarian respondents are more likely to be ahead in terms of professionality, while the Slovak respondents achieved better results in terms of first impression and appearance on job interviews. Since most of the individuals participating in the research were university students, the findings of the conducted research might be useful for the institutions of higher education, as the areas where the respondents still need improvement – self marketing – were identified. The previously mentioned self-marketing plan would be useful for the Slovak and Hungarian institutions of higher education, but it is important to take into consideration those specifics that were identified in our research regarding the specific sample.

5. Conclusions

The theoretical part of this study addressed the issue of brand building and self-marketing. Based on the introduced scientific background, the difference between the two concepts can be defined as personal brand is a phenomenon, while self-marketing is an activity: self-marketing is an activity used to develop personal brand. Self-marketing is an activity needed by every individual both in private and professional life. The purpose of conducting our research was to map the self-marketing activities of people present on the Slovak and the Hungarian labor market, and identify whether there is difference between the job seekers of two countries in terms how well-prepared the respondents are to enter the world of work. The results and conclusion of our research were summarized in the previous chapter. The practical benefit of this study can be found in the fact that the formulated questions and statements during the research can be used by further authors, since we identified two important fields of self-marketing: professionality and appearance. When processing the scientific literature available, we found only few research results addressing those aspects that measure the self-marketing of job applicants. This is why we think that we managed to provide useful ideas and results in this field that serve scientific purpose. As a barrier to our research activity, it has to be mentioned that the pandemic situation did not allow us to use a methodology based on personal interviews. As for the future goals, we find it important to work with a more transparent sample than we presented in this study, so the online questionnaire both in Slovak and Hungarian language is still available. Our further goal is to extend the research to other Central-European countries, in order to make a comparison on greater scale, as well as to examine self-marketing also within specific sectors.

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Conflict of interest: none

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Banking Habits of Women in Hungary at the Time of Economic Difficulties – Pilot Study

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Abstract: The aim of the research is to access the banking habits of Hungarian Women. The research was conducted at the time full of economic difficulties. Firstly, the Covid-19 changed the economic behavior of individuals. After that, due to the Russo-Ukrainian war and its consequences the individuals have become even more cautious in the field of finances. Questionnaire research was conducted (n = 437). According to the results, the majority of the respondents opened their first bank account more the five years ago, and were influenced by the workplace and family members. Most of the Hungarian women spend more than 160,000 HUF with card in a month. The number of women having investments at their bank is quite low. Half of them started using these investment services more than 5 years ago, and the size of the investment differs from case to case. Our hypothesis ("The number of ATMs is one of the most significant factor when choosing a bank") was rejected. The results of this study should be served as a great base for future research.

Keywords: banking habits; commercial banks; banking services; women; Hungary; Russo-Ukrainian war

JEL Classification: G21; G20

1. Introduction

In recent years, large-scale economic changes have occurred throughout the world. Part of this is due to the Covid-19 pandemic, which was an unprecedented phenomenon for most of the world's population. Quarantine obligations, closures, home office and factory shutdowns have taken a significant toll on the nations' economies. Just when it seemed that there was a straight path ahead of us – the way out of the pandemic – another threat appeared on the border: the war. The significance of this was also incomprehensible to the majority of the European population, since the last wars took place decades ago, while the World Wars only remained in the stories of our ancestors and in historical records. The effects of these two phenomena (pandemic and war) had a significance that we had not even expected before – extreme inflation, energy shortages and social tensions. In the course of our research, we wanted to examine the banking habits of individuals, which received great emphasis in light of the above-mentioned events. For this, we would first like to present the banking system itself (Csiszárik-Kocsir, 2021; Jackson et al., 2021).

A two-tier banking system operates in Hungary, so commercial banks also operate in addition to the central National Bank of Hungary (NBH, in Hungarian "Magyar Nemzeti

Bank"). Their functions are separate. In this chapter, we do not describe the two-tier banking system, but we present the tasks and services of commercial banks (Fehér & Varga, 2017).

A commercial bank is an institution of the banking system that is a profit-oriented economic organization and provides financial services. Its most important activities are collecting the deposits and granting loans, i.e. financial intermediation. It transfers temporarily unused money back into the economy, thus acting as an engine of the economy. The bank is also a risk-trading business, which is carried out in the hope of profit. Its profit come from the difference between the interest income received from the loans and interest paid on deposits and operating costs. A typical banking activity is also the processing of payment transactions, as well as the execution of currency and foreign exchange transactions. The scope of activities of the commercial banks also includes consulting, trading precious metals, facilitating foreign trade transactions, leasing, factoring, asset management, management of investment funds and stock exchange activities. Banks provide both retail and wholesale banking services. The former generally includes private, micro and small business services, while the latter includes banking activities and interbank operations for medium and large companies, municipalities, various state and civil organizations. The operation of a commercial bank is subject to a license and is subject to a number of strict legal and regulatory requirements (Fehér & Varga, 2017; Solti, 2019; Tan & Trang, 2019; Okewale et al., 2020; Li et al., 2022).

The range of other banking services offered by commercial banks is increasing, but their common feature is that they do not cause any claims or debts for the bank. Banks offer these activities for a fixed fee (Tan & Trang, 2019; Berber et al., 2020).

In order to be able to meet the wide-ranging legislative and supervisory requirements and the needs of customers and shareholders, a well-organized banking operation is necessary. The organizational structure of European commercial banks is regulated by strict legal regulations, including regulations on the delimitation of tasks and responsibilities (exclusion of conflicts of interest). In addition, the organizational structure must comply with the financial institution's goals, business model, risk profile, size, geographical scope and complexity of activities, operated sales channels and, in the case of subsidiaries, the size and structure of the banking group. In Europe, commercial banks can only be established and operated in the form of a joint-stock company, with registered shares, so that the bank's owners can always be identified (Berber et al., 2019; Iwanicz-Drozdowska & Witkowski, 2022; Li et al., 2022).

The highest body of a commercial bank is the general assembly consisting of shareholders, which exercises ownership rights, and the board of directors. The aforementioned bodies determine the bank's strategic direction, approve the bank's balance sheet and annual report, and other annual and longer-term plans. In order to comply with the prudential requirements, the supervisory authority may – in justified cases – require the owners to take certain measures, which may be a capital increase. The board of directors convenes the general meeting once a year. The board of directors is the executive body elected by the general meeting, which manages the bank and exercises the employer's rights. Its members must comply with strict rules, in most EU countries the legal requirement is, for

example, a good reputation, the existence of appropriate professional knowledge, skills and experience and the absence of conflicts of interest. The task of management is to manage the organization and the continuous operation of the company. The bank's executive bodies include the standing committees, which are the bank's decision-making and deliberative bodies (Kavitha & Gopinath, 2020; Iwanicz-Drozdowska & Witkowski, 2022).

The supervisory board is the body with the highest supervisory and control powers. Its most important tasks are to ensure regular operation, to regularly review the activities of the board of directors, the legal operation and results of the bank, and the implementation of the strategy. It also monitors the operation of internal defense lines and supervises internal control activities. This committee is also elected by the general meeting, and in some banks, it even has decision-making authority. The two most important permanent banking committees are the credit and the asset-liability committees. The task of the credit committee is to decide on the bank's individual commitments, while the task of the asset-liability committee is to manage the bank's liquidity position, balance sheet, and off-balance sheet items. Its main task is to manage the bank's interest and maturity risks, to make a decision about the bank's interest rate and placement structure (Solti, 2019; Li et al., 2022).

When developing the organization of commercial banks, it must be kept in mind that the existence and independence of some specialized areas are required by law, just as the back-end operational areas performing the administration of the business areas and risk management must be independent from the business areas. Accordingly, the front office that deals directly with customers, the back office that performs background activities, the risk management that measures and manages the bank's risks, and the central areas are separated from each other within the bank. At larger banks, the retail and corporate business is separated. The strategic, controlling, financial and asset-resource management specialist areas, the staff and the departments supporting the banking operation are also separated (Kavitha & Gopinath, 2020; Li et al., 2022).

The main departments of an average European commercial bank are the following:

- retail,
- corporate,
- investment banking,
- card,
- treasury,
- depositary.

This range of activities includes both active operations affecting the asset side of the bank's balance sheet and passive operations affecting the credit side, as well as functions supporting account management and business activities (Solti, 2019; Iwanicz-Drozdowska & Witkowski, 2022).

Bank strategists are responsible for developing the institution's vision and mission. The strategic plan – that follows from the vision and mission – formulates goals for a time period of 3-10 years and includes the long-term concepts of the owners and the management regarding the operation and effectiveness of the bank. The bank's strategic department

develops and maintains this plan, which is backed by serious and professional analytical work. In the light of the analyses, the bank can set achievable goals for itself. The business model of banks is significantly different from that of production companies. First of all, strong regulation, special requirements (such as capital requirements and close supervision) require serious investment and capacity, and this significantly limits financial institutions' leeway. On the other hand, long-term customer relationships are typical on the banking market, which helps customer acquisition. The specialist area designates specific business and product-specific goals from the bank's approved strategy, which are quantified by the controlling specialist area in the context of annual and medium-term planning. These days the biggest challenges for banking strategies are digitization, the rise of fintech companies and the exploitation of the potential of data analysis. Health (Covid-19) and social, political (Russo-Ukranian war) issues are also creating difficulties for the banking sector (Csiszárik-Kocsir, 2019; Solti, 2019; Dunbar, 2022; Foglia et al., 2022; Lo et al., 2022).

The essence of the bank's operation is the assumption of risks from customers, and its income basically derives from this. For this reason, accurate knowledge, measurement and competent, professional management of risks is not only fundamental, but also critically important for a financial institution. The bank manages its risks according to the principles defined in its “risk management strategy” and other risk management policies. One of the most common types of banking risks is credit risk, which means the uncertainty of repayment of disbursed credits. Banks try to reduce credit risk in various ways, for example by using credit assessment and credit (debtor) rating systems. Requiring credit collateral and risk pricing also serve to reduce the risk. The higher the risk of the loan, the higher the loan interest charged by the bank to cover possible losses. When managing credit risks, banks try to create lending and credit tracking processes that can be used to reduce not only the risk of non-payment, but also the expected loss in the case of non-payment (Sahiti et al, 2022; Li et al., 2022).

Even with the most careful credit risk management and thorough credit monitoring activities, it happens in all banks that some customers do not or partially do not pay back their loan debts, so banks try to enforce their claims that can no longer be handled in the normal course of business in special areas. Receivables management (or claims management) is all activity that banks perform to recover their overdue claims against their customers. During the process of receivables management, bank specialists try to cooperate with clients in order to maximize the amounts received from receivables and minimize losses. Banks have a so called “work out committee” that makes decisions about the enforcement methods of claims with a compromised return, possible sales of claims and write-offs. Their important task is to keep the size of the bank's non-performing loans below the level required by law. Within this framework, certain stocks may be sold and bad debts written off. When selling overdue receivables, the bank calls out a tender for companies specializing in debt collection, and the deal is concluded with the one that makes the most favorable offer for the purchase of the receivables. After the sale, the holder of the claims will be the company that bought it (Solti, 2019; Sahiti et al, 2022).

2. Methodology

The aim of the research is to assess the banking habits of Hungarian women having bank accounts. All of this was assessed in the difficult economic situation weighed down by the after-effects of Covid-19 and the current events of war in Eastern Europe. The questionnaire research – which belongs to the group of quantitative methods – proved to be the most suitable for the preparation of the research. The questionnaire contained closed and Likert scale questions.

A snowball method was used during data collection. The questionnaire was completed online (Survio) between 1st of September and 30th of November in 2022. With the help of this method, a total of 458 responses were received. However, responses from men and individuals under 18 were excluded from these. In addition, the database had to be cleaned of outliers. In light of the facts mentioned above, the analysis was finally based on 437 valid answers. The number of items (n = 437) fully corresponds to the minimum number of items (n = 385) defined by Cochran (1977).

Since the data collected by nominal and ordinal scales can usually be treated as non-metric, the data analysis was based on this principle (Frankfort-Nachmias & Leon-Guerro, 2011; Nunan et al., 2020). Due to this the available statistical methods were extremely limited. For this reason, only the frequencies were indicated in each case.

Below are the demographic characteristics of the sampled individuals.

Table 1. Demographics of the respondents

	Category	%
Age	18-25	21.2
	26-35	33:5
	36-45	23.1
	46-55	16.4
	55 and above	5.8
Residence	Village	30.6
	Town or City	57.8
	Capital	11.6
Education	Elementary	1.5
	Secondary Vocational Education	13.9
	High School	38.9
	University	45.7

As mentioned above, only female responses from Hungary were taken into account. In addition, for ethical reasons, the opinions of those under the age of 18 were not included in the analysis. Another criterion was that the individuals had a bank account at a commercial bank.

Based on Mokhlis et al. (2009) and Srouji (2018) we formulated one hypothesis:

- H1: The number of ATMs is one of the most significant factors when choosing a bank.

3. Results

Below the responses received from users are evaluated. The first question on banking habits dealt with how long the respondents had been keeping their current account at their chosen bank. Most of the respondents opened their first bank account more than 5 years ago.

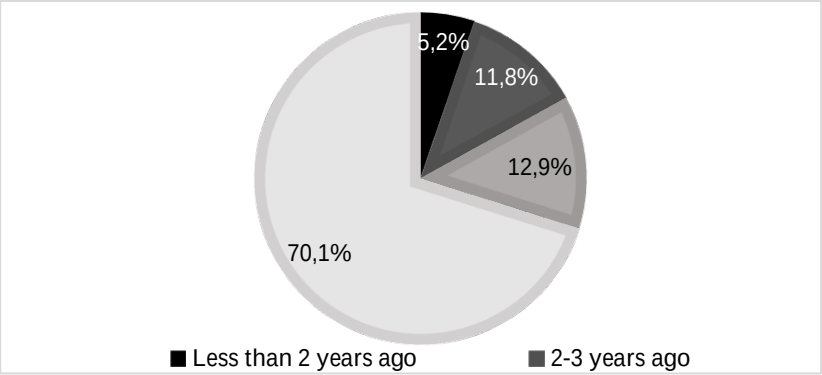

Figure 1. The date of account opening

The result is not surprising, because as we highlighted earlier, all of our applicants are over 18 years old, so most of them are already employed members of the labor market. The income from employment and the payment of individual bills almost require the existence of a banking account.

In order to map banking habits, it is essential to know the criteria on which the respondents chose their account-managing bank. To access this, we listed various items to our respondents, who could tick several answers. Most of the respondents opened their current account in a particular bank because of their workplace. This may also mean that the individual's workplace is the same as the company's bank. This may also mean that the bank of the individual working for the organization is the same as the organization's bank, or that the person works for a company that has an agreement with the bank regarding favorable account management.

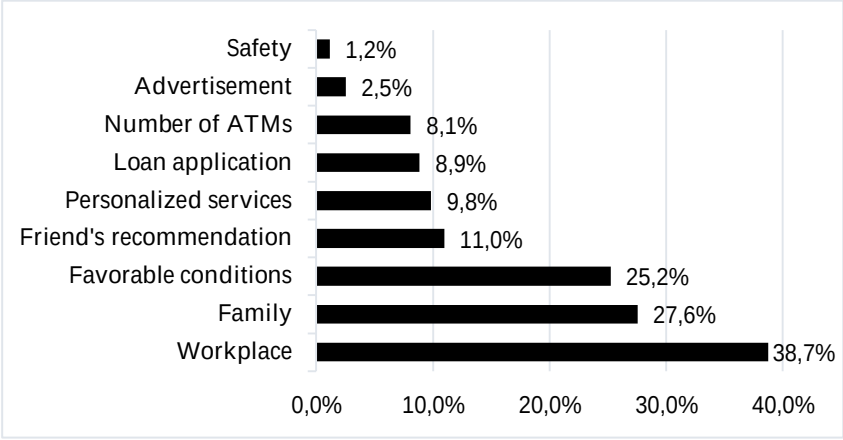

Figure 2. Reasons behind choosing the given bank

A high proportion of respondents indicated that they chose the bank due to the influence of their family members. These habits are mainly due to the fact that the older members of their family already had accounts at the given bank before they reached the point where they also needed a bank account. It is interesting to point out that nearly 9 percent of the respondents chose a bank because they wanted to apply for a loan. The reason for this is that, commercial banks tie the disbursement of the loan to the existence of a current account at the given bank. Those intending to take out a loan want to choose the most favorable loan

possible. In light of this, they are able to transfer their account to a competing institution or open a second account with them. Safety – as an influencing factor – is ranked last. In our opinion, the reason for this is that nowadays users trust each bank equally, or they do not doubt their security systems. According to the Figure 2. our hypothesis can be rejected.

We were also curious about how many Hungarian forints (HUF) the surveyed women spend monthly by using their bank cards. So, we only asked them about bank card payments. It can be seen that most of them (21.4%) spend more than 160,000 HUF (approx. 405 EUR) per month using their card.

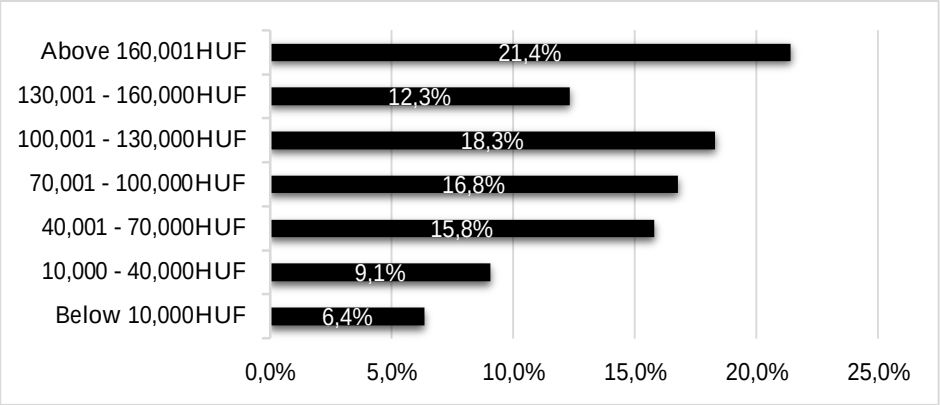

Figure 3. Purchases made with card (in HUF)

We then asked our respondents about the frequency of use of the listed services. Based on the results, they most often (45.9%) use various "electronic services". This is followed by "transfers" (29.1%). The proportion of those who indicated the "buying time deposits" option as the least frequently used service was high. In the case of this option, we need to point out that this type of investment is usually tied to a longer period of time, so it is not surprising that these services are used relatively less often. On the other hand, the fact that 51.8% have never used these services of the banks can be a bit worrying. These investments can be suitable opportunities for clients to get a smaller profit or at least recover the loss caused by inflation. "Check payments" are used even less often (57.8% never). In our opinion, this is not surprising, as the "Hungarian Post" (in Hungarian: "Magyar Posta") also provides similar services.

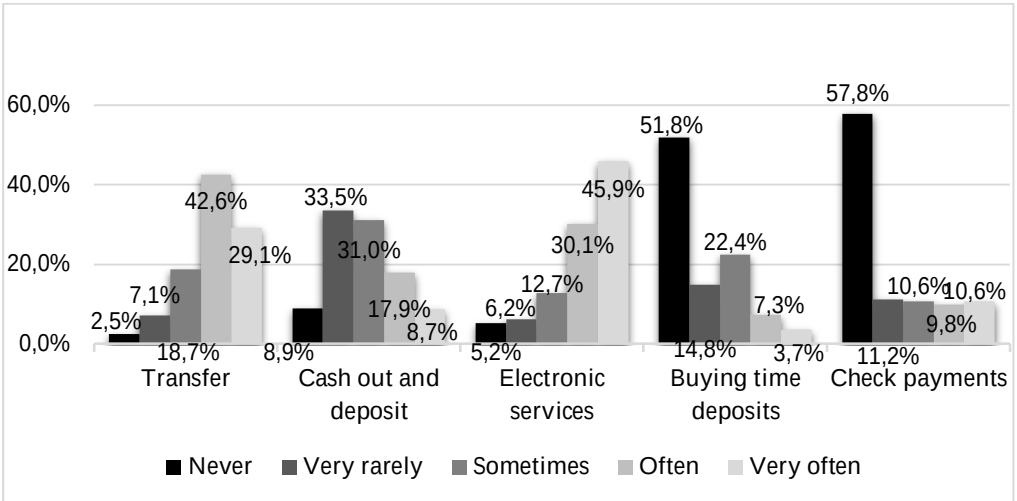

Figure 4. Frequency of using the bank's services

66.3% of the respondents prefer online administration and strive to manage their bank-related matters in this way as well. In contrast, only 33.7% of the respondents like to handle their banking affairs personally. In our opinion, this ratio is due to the "rushing lifestyle". On the other hand, the habits developed by Covid-19 also changed the attitude of individuals. 42.2% are completely satisfied (5), while 41.4% are mostly (4) satisfied with the bank's online administration service.

In light of this, it is not surprising that 97.3% of the respondents use the internet banking services of their bank accounts. Of these, they are most often used to track transactions and send HUF-based outgoing transfers. The proportion of those who use these services daily (28.9%) and weekly (51.5%) is exceptionally high. 96.9% of all respondents consider internet banking to be completely safe. This therefore coincides with the proportion of users.

We then asked our respondents what kind of investments they had at their banks. It turned out that only 37.0% of the interviewed women have some kind of bank investments. Then we were only interested in their (n = 162) opinion. We wanted to find out what types of investments they have. Based on the answers, most of the respondents have "Premium bond" type investments (60.4%). The proportion of respondents who have "State bonds" can be said to be relatively high (33.9%). It is important to mention that 1-1 respondents could mark several answers, so overlaps can be discovered between individual answers. In all cases, 100% means the number of those with bank investments (n = 162).

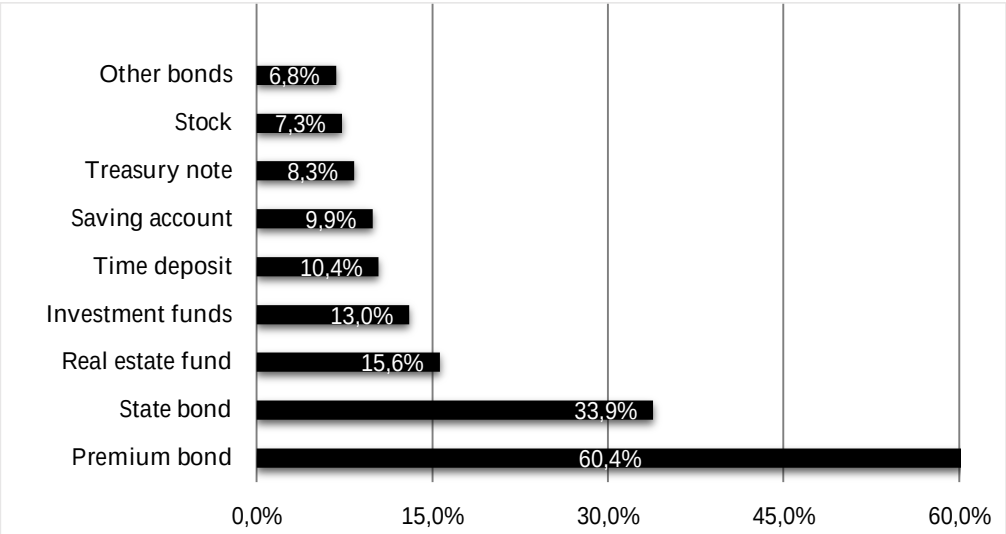

Figure 5. Type of investments

We also found out that 45.9% of the respondents have had this type of investment for more than 5 years. Another 30.2% decided to use some of the bank's investment services more than two but less than five years ago. 23.9% of those with investments have been using these opportunities for less than 2 years.

Then we also asked the respondents about the size of the investment. In this case, the 2 extreme values took first place. The value of the investment in the most cases (23.2%) is less than 100,000 HUF (approx. 250 EUR). This is an extremely small amount. At the same time, 21.8% of investors have investments of more than 3 million HUF (approx. 7,600 EUR). The further distribution is shown in Figure 6 below.

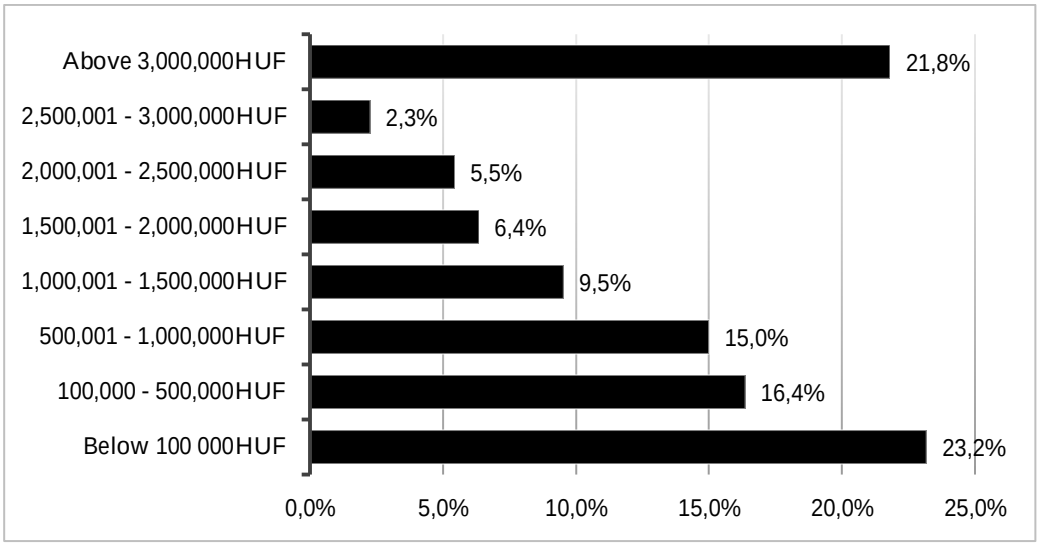

Figure 6. Size of the investments

4. Discussion and Conclusions

The aim of our research was to access the banking habits of women in Hungary at the time of economic difficulties. The results are based on 437 valid answers from women, all 18 years old or older.

According to the results, the majority of the respondents opened their first bank account more the five years ago. Choosing the right bank is mainly influenced by the workplace, family and other favorable conditions. The authors did not find previous articles dealing with the banking habits of women in Hungary. However, there are some previous studies dealing with the factors influencing bank selection. Paper by Mokhlis et al. (2009) found, that the main influencing factors are attractiveness, branch location, ATM service, financial benefits and secure feeling when choosing the most appropriate bank. On the other hand, Sayani and Miniaoui (2013) found that bank reputation and expectation of profit on deposits are not significant factors, while religious preferences are the most important determinants. It is important to mention that they were studying the selection between Islamic and conventional banks. Srouji (2018, p. 82) et al. also studied the determinants of bank selection in relation to Islamic and conventional banks. They found that: "*While bank convenience, and bank reputation and images was positively significant for both type of banks, but quality of services, location of branches, availability of ATMs', efficiency in carrying-out transactions, facilities provided by banks and the reputation and bank image were significant to conventional bank clients selection only*."

Using credit cards while purchasing goods online or offline is popular among Hungarian women too. The most of them spend more than 160,000 HUF in a month, which is about 405 EUR. Using different "electronic services" and "transfers" are the most popular among all services. Two thirds of the respondents prefer online administration and they are satisfied with the process of that. They also consider online banking safety, which is shown in the high frequency (most of the respondents weekly or even daily) of the usage.

The number of women having investments with the help of their banks is quite low. Most of them investing in "premium" or "state" bonds. Nearly half of these investors started using

these services more than 5 years ago. Most of them invested below 100,000 HUF (250 EUR) or above 3,000,000 HUF (7,600 EUR), which is quite conflicting.

The research had some limitations. First of all, the self-administered questionnaire is based on the subjective opinion and sincerity of the respondents. Misunderstandings should also emerge, and the respondents do not have anybody near to ask for making the question clear for them. In addition, frequency is the only statistic method used, since the nature of the questions (nominal and ordinal scales) and the data gathered by these (non metric) made possible only this method.

The results of this study should be served as a great base for future research. A deeper statistical examination is among our primary plans. In the future we would like to repeat the research, since the economic difficulties caused by the Russo-Ukrainian war and sanctions related to the conflict made the situation more worrying for the population. Also, a research comparing men and women is among our primary goals for the future.

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Conflict of interest: none

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Assessment of Sustainability by Project Management Maturity Models

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Abstract: Sustainability is included in a wide range of activities, including the implementation of changes and the execution of projects. On a general level, a number of tools are available to assess sustainability, and to what extent and is integration into social activities. Specific project management maturity models are available for the assessment of sustainability within project environment. The aim of the article is to identify and interrogate 70 plus project management maturity models focused on sustainability. The study will evaluate the range of this assessment based on the indicators of sustainability and evaluate the usage of such models and attitude of project managers to sustainability in practice. Three project management maturity models with a particular focus on sustainability have been identified with a defined methodology, they evaluate key sustainability indicators in project. On the flip side their usage in practice is insufficient. In the Czech Republic and Ireland these tools are almost unknown among project managers.

Keywords: project management; project management maturity models; sustainability; Czech Republic; Ireland

JEL Classification: O22; Q01

1. Introduction

In accordance with the latest trends in the field of project management (Kostalova & McGrath, 2020) one of the areas, that is at the forefront, is the implementation and assessment of sustainability in projects. Sustainability can be evaluated from the project output point of view and project processes point of view. The adaption of sustainable approaches is slow despite it being recognized as a key capability for almost all activities of human society in the developed world.

Sustainability itself has many definitions and there is a long-term discussion about its definition (Brown et al. 1987; Watkin, 1999; Waseen & Kota, 2017). Its main goal is to balance economic growth, social wellbeing and reasonable distribution and use of natural resources (Keating, 1993; Henderson & Loreau, 2023). Sustainable goals are also specified by international standards like Global Reporting Initiative (GRI) (GRI, 2016), UN Global Compact (2014), AA 1000 AccountAbility (2018), the OECD Guidelines for Multinational Enterprises (2011), SA 8000 (Social Accountability International, 2014), or ISO 26000 (ISO 26000, 2010) or by European Union in Green Deal (European Commission, 2020). Assessment of sustainability is evaluated by many types of tools. There are sustainability maturity models

available such as the Maturity Model for Sustainability in New Product Development (Hynds et al, 2014), Business Sustainability Maturity Model (Cagnin et al., 2005), and model measured Business Sustainability Maturity Levels (Meza-Ruiz et al., 2017).

In area of project management there are also international standards like PMI (Project Management Institute, 2021), IPMA (International Project Management Association, 2020), and PRINCE2 (2022). Based on these standards or methodologies the project management maturity models (PMMMs) have been developed and adapted to assess the maturity of project, program and portfolio management. The view on project management from sustainable point of view is connected with expanding the sustainable approach generally. In addition to the basic project management assessment tools, with this approach there are new criteria for evaluating the extent to which the project itself or its outputs are in line with sustainable goals. Silvius and Schipper (2015), Martens and Carvalho (2016), Carvalho and Rabechini (2017) specify the sustainable project management and recommend to evaluate success of projects and its project management also from this point of view.

The objective of the research is to specify the PMMMs oriented on evaluation of sustainability in project management, evaluation the range of this assessment based on the indicators of sustainability and evaluate the usage of such models in practice.

2. Literature Review

As a result of a literature review among more than 70 PMMMs for assessing the level of project management (Ofori & Deffor, 2013; Spalek, 2015; Kwak et al., 2015; Iqbal, 2016; Kostalova & Tetrevova, 2018), three models that focus on the assessment of sustainability in project management were identified, all of them with a focus on the assessment of the sustainability of the output and with a focus on the assessment of the sustainability of the procedures themselves within the project:

- Sustainable Project Management Maturity Model (Silvius et al., 2012, Silvius & Schipper, 2015).
- The GPM® Organizational Model for Sustainable Organizations, Portfolios, Programs, and Projects (Carboni et al., 2018; GPM, 2019; GPM, 2009).
- Management Maturity Model for project-based organizational performance assessment (Langston & Ghanbaripour, 2016).

Sustainable Project Management Maturity Model (Silvius et al., 2012, Silvius & Schipper, 2015) is a model focused on the assessment of sustainability in project management, but the approach to sustainability at the organizational level is also assessed. The model focuses on evaluating the level of sustainability in project management. It also considers the organization's overall approach to sustainability. It is based on the basic principles of sustainability:

- Sustainability is focused on balancing or harmonizing social, environmental and economic interests.
- Sustainability is both short-term and long-term oriented.
- Sustainability is about local and global orientation.
- Sustainability is about consumption of income not capital.
- Sustainability is about transparency and accountability.

- Sustainability is about personal values and an ethical approach.

The author of the model is team led by G. Silvius from Netherlands (2012). The model focuses on evaluation two areas:

- Project process – assesses how processes are carried out and their impact on sustainability.
- Project product outputs – assesses to what extent stakeholders are impacted during the development of the project outputs and what impact the project outputs have on the environment.

The model has four levels, the contribution to sustainability increases gradually (Silvius & Schipper, 2015):

- Level 1: Compliant – Sustainability is considered minimalistic and implicit, and (only) with the intention to comply with laws and regulations.
- Level 2: Reactive – Sustainability is considered explicitly, with the intention to reduce negative impacts of the project.
- Level 3: Proactive – Sustainability is explicitly considered as one of the areas that the project contributes to.
- Level 4: Purpose – Contributing to (this aspect of) sustainability is one of the drivers behind the project and sustainability considerations are included in the justification of the project.

Each level has recommended values of economic, environmental and social sustainability indicators. By raising the level according to the model, the organization as a whole also moves from reactive to proactive, to an organization that positively affects the sustainability of its environment and its activities.

GPM® Organizational Model for Sustainable Organizations, Portfolios, Programs, and Projects (Carboni et al., 2018; GPM, 2019; GPM, 2009) (PSM3™) is a model evaluating the degree of sustainability considered within the organization's projects. The model is based on the GPMTM Standard for Sustainability in Project Management of the American social society Green project management, introduced in 2010, which defines six principles of sustainability that should be incorporated into project management to make it sustainable. These principles are (Carboni et al., 2018):

- Commitment and accountability – recognize the fundamental rights of all to a healthy, clean and safe environment, equal opportunity, fair remuneration, ethical procurement and compliance.
- Ethics and decision making – promote ethical approaches and decision-making at the level of the organization with respect for universal principles through the identification, mitigation and prevention of adverse short-term and long-term impacts on society and the environment:
- Integrated and transparent – to support the interdependence of economic development, social integrity and environmental protection in all aspects of governance, practice and reporting.
- Principles and values based – protect and improve our natural resource base by improving the ways we develop and use technologies and resources.

- Social and ecological equity – assess human vulnerability and impact on ecologically sensitive areas and centers through demographic dynamics of population growth.
- Economic prosperity – adhere to fiscal strategies, goals that balance the needs of stakeholders, including immediate needs, and the needs of future generations.

Model PSM3™ has got six levels of maturity (GPM, 2019; GPM, 2009). The model assesses sustainability within 24 areas. The lowest level is defined as undefined, indicating a lack of sustainability practices and balancing on the edge regarding compliance with social and legal rules. The second level is called provisional. It is characteristic of organizations with ad hoc sustainable practices with little consistency. The third level, foundational, refers to the level where the organization already complies with the rules in the area of health, safety and environmental protection. The fourth level essential indicates a proactive approach of the organization towards increasing profitability using eco-friendly practices. The fifth level, called optimized, aligns company principles and values with a sustainable model, looks for opportunities to improve products and services. The highest level of principled, based on decisions to create value to improve society and the environment through its products and services (GPM, 2019; GPM, 2009). The assessment can be carried out by external GPM experts. In addition to evaluation as a service, GPM also offers certification of knowledge in the field of sustainable project management and trainer training, available here (GPM, 2019; GPM, 2009).

A Management Maturity Model (MMM) for project-based organizational performance assessment (Langston & Ghanbaripour, 2016) was developed by the authors to assess project management at the organizational level using a tailored, strategically oriented and practical methodology without having to adhere to rigid maturity assessment approaches. It can be used to evaluate the management of projects, programs and portfolio management. The model is developed cognizant with the fact that it is not possible to use a universal evaluation procedure for all organizations, regardless of their scope, scope, complexity and types of projects that are implemented in the organization. The model is partly based on the approach of defining competences with the help of IPMA competencies and PMI's knowledge areas listed in PMBoK (Project Management Institute, 2021). It also tries to include a modern approach to so-called sustainable project management or environmental project management, i.e. sustainable project management in a way that takes into account the impact on the environment, both from the perspective of planning and implementation procedures, and from the perspective of project outputs (Silvius et al., 2012; Ebbensen & Hope, 2013; Hwang & Ng, 2013).

It defines six key project indicators important for assessing project success (value, efficiency, speed, innovativeness, level of complexity and impact) and other overall key indicators aimed at evaluating the cumulative effects of the four success factors (scope, cost, time and risk). A calculation method is defined for all indicators. Maturity values are calculated for 28 items and the total maturity at the level of project, program and portfolio management consists of these (Langston & Ghanbaripour, 2016). A deeper assessment of these 28 items is not possible because they are not presented in detail.

The model is focused on the strategic and continuous improvement of project management in the organization and uses the PDCA procedure (Sokovic et al., 2010) from quality

management (P – plan: set goals, D – do: measure outputs, C – check: performance assessment and A – act: improve according to identified deficiencies.). Thus, it is evaluated to what extent this procedure is applied in individual dimensions. The evaluation takes place by self-assessment with control by evaluators. Templates for the count are freely available on request from the authors. This assumes that trained evaluators with certification in the area are available. The authors assume an active role of associations in the field of project management such as IPMA or APM and offering a model for evaluation, possibly creating a database of suitable evaluators (Langston & Ghanbaripour, 2016).

3. Methodology

The basis of the research was the primary analysis of secondary sources on the topic of PMMMs and identification of sustainable oriented PMMMs. The goal was to identify PMMMs oriented to the assessment of sustainability of project management. Compare how the models are designed, what evaluation method they use and what indicators of sustainability they assess, based on the sustainability indicators for PMMMs assessment identified by Kostalova and McGrath (2021). Furthermore, the goal of the research was to assess whether these models are known to experts in practice and how widespread they are in practice. Due to the transnational availability of these models, this analysis was extended to two European countries, the Czech Republic and Ireland. To fulfill this goal, qualitative research methods were chosen, namely comparative analysis and structured interviews with project managers – experts from practice in the Czech Republic and Ireland.

4. Results

In the first part of the research, sustainability oriented PMMMs were assessed and compared from the perspective of sustainability indicators for PMMMs assessment (Kostalova & Grath, 2021). The summary of sustainable indicators has been prepared based on the general sustainable indicators by GRI standard (2016), Meza-Ruiz et al. (2017), Martens and Carvalho (2016), Lin et al. (2017) and Banishashemi et al. (2017) (see Table 1). Management Maturity Model (MMM) for project-based organizational performance assessment (Langston & Ghanbaripour, 2016) is presented in available publications only generally, in group of indicators focused on impact of projects the evaluation of sustainability in outcomes and resource consumption is mentioned, but the detail overview of indicators that are focused on sustainability is not available. Based on that only Sustainable Project Management Maturity Model (Silvius et al., 2012, Silvius & Schipper, 2015) and PSM3™ (Carboni et al., 2018; GPM, 2019; GPM, 2009) (PSM3™) are assessed.

In the second part of the research, project managers from practice in the Czech Republic and Ireland were interviewed. The research respondents included project managers from private practice, public sector and non-profit sector (10 respondent from each country). Data were obtained in the form of a structured interview.

In the Czech Republic, among the interviewed project managers, sustainability is rated as a very important area. However, its application to the practice of solving organizations is weaker. The majority agreed that they perceive the incorporation of a sustainable approach

Table 1. Sustainability Indicators for PMMMs assessment (Part 1). Own processing based on the GRI standard (2016), Meza-Ruiz et al. (2017), Martens and Carvalho (2016), Lin et al. (2017), Banishashemi et al. (2017) and Kostalova and McGrath (2021)

Group	Sustainability Indicators for PMMMs assessment	Sustainable Project Management Maturity Model	PSM3™
General Sustainability Indicators	Managerial Approach	-	X
	Business Ethics	X	X
	Innovation Management	-	-
	Organizational Culture Management	-	X
	Responsibility for Product and Services	X	-
	Assessment of Technological Feasibility of Project	-	X
	Improvement	-	-
	Obey Law and observe disciplines	X	-
	Ensure Quality and Safety	X	-
	Philanthropy	-	X
	Transparent Information and Reporting	X	X
	Green Designing and Construction	X	-
	Collaboration	X	-
	Implementing an Effective Quality Control	-	-
	Implementing an Effective Project Risk Management	-	X
	Strategic Management	X	-
	Knowledge Management	X	-
	Awareness of Sustainability	X	-
	No Conflict of Interest	X	-
	Effective Project Control	X	-
	Lessons Learned Focused on Sustainability	X	-
Economic Sustainability Indicators	Assessment of Economic Feasibility of Project	X	X
	Financial and Economic Performance	X	
	Financial Benefits from Good Social and Environmental Practices	X	X
	Ensure Shareholders Economic Interest	-	-
	Market Presence	X	X
	Indirect Economic Impacts	X	X
	Transparent and competitive procurement processes	X	X
	Anti-corruption	X	X
	Anti-competitive Behavior	X	X
	Tax	-	-
	Cost Management	-	-
	Increase in Profitability	X	-
	Reasonable Return on Investment	X	X
	Perpetuation of Environmental Benefit of the Project	-	X
	Efficiency Utilize Resources	-	-
	Recycling of Resources	X	X
Environmental Sustainability Indicators	Nature Resources Minimization	X	-
	Materials Minimization	X	-
	Energy Minimization	X	X
	Water and Effluents Minimization	X	X
	Ground, Ground Pollution	-	X
	Air, Air Pollution	X	X
	Biodiversity	X	X
	Emissions	X	X

Table 1. Sustainability Indicators for PMMMs assessment (Part 2). Own processing based on the GRI standard (2016), Meza-Ruiz et al. (2017), Martens and Carvalho (2016), Lin et al. (2017), Banishashemi et al. (2017) and Kostalova and McGrath (2021)

Group	Sustainability Indicators for PMMMs assessment	Sustainable Project Management Maturity Model	PSM3™
Environmental Sustainability Indicators	Waste Management	X	X
	Environmental Compliance	X	-
	Supplier Environmental Assessment	X	X
	Eco-efficiency	-	-
	Management of Environmental Impacts	X	-
	Environmental Policy Management	-	-
	Environmental Commitment and Responsibility	X	-
	Protect Environment	-	-
Social Sustainability Indicators	Employment	X	X
	Labor/Management Relations	X	X
	Occupational Health and Safety	X	X
	Training and Education	X	X
	Support and cooperation of Project Management Team in delivering a sustainable project	X	-
	Diversity and Equal Opportunity	X	X
	Non-discrimination	X	X
	Freedom of Association and Collective Bargaining	X	
	Child Labor Forced or Compulsory Labor	X	X
	Security Practices	X	-
	Rights of Indigenous People		X
	Human Rights Assessment	X	X
	Local Communities/Relationship with Society	X	X
	Relationship with Stakeholders	X	X
	Relationship with Suppliers and Contractors	X	-
	Supplier Social Assessment	X	-
	Public Policy	X	X
	Community involvement	X	X
	Customer Health and Safety	X	X
	Customer Relationship Management	X	X
	Marketing and Labeling	X	X
	Customer Privacy	X	X
	Socioeconomic Compliance		X
	Participation and Involvement of Stakeholders	X	X
	Impact on the Professional Life of the Team Members	X	-
	Satisfaction and Productivity of the Team	-	-
	Perpetuation of Social Benefit of the Project	-	X
	Motivation	-	-
	Human Capital Development	X	-
	Corporate Citizenship	-	-

Note: X = indicator is evaluated, - = indicator is not evaluated.

into project management as very important, especially from a personal point of view. However, the majority agreed that this is not the case at the organizational level, where the emphasis on a sustainable approach is much less intensive. The reason is not so much a lack of interest in this area, but a prevailing view within organizations that there are more

important and acute items for immediate management (management of the basic parameters of projects – scope, time, budget, changes and risk management).

The positive thing is that the majority of project managers confirmed that project management is connected to the strategic management of organizations and in several cases, sustainability is starting to become a part of strategic visions and thus is also reflected in the definition of project products or outputs (banking and insurance sectors, logistics, R&D).

If the success criteria for projects are evaluated with a focus on sustainability, rather than just an assessment of social aspects or indicators, safety and impact on health, prioritization of online meetings of international teams, paperless administration, energy saving and a turn to recyclable materials. In some companies, sustainable indicators become part of an in-house evaluation procedures as part of internal audit, they are not aimed directly at project management, but all activity in the organization is assessed with their help.

In many cases, project managers connected sustainable project management with the company's overall approach – the development of a sustainable corporate culture, the expansion of Corporate social responsibility (CSR) or environmental, social and government (ESG) investment, product specification and reporting. Regarding the awareness of sustainable PMMMs among ten project managers from the Czech Republic only one declared knowledge of PSM3™. Most of them declared that in case of availability of a simple tool for evaluation, they will use PMMMs and sustainable PMMMs. They generally expect changes in this area from the external environment and society rather than strengthening the sustainable approach from internal initiatives.

In the Irish context, the linkage of project controls with sustainability is significant. There have been various theories that address sustainable processes such as 'lean sustainability' that may be effective for improving project efficiency and process waste, there is still limited knowledge around how to effectively use such theories and concepts to adopt in project controls. Sustainability is foundationally concerned with three pillars being profit, people and the planet. In the Irish project management community, there is a tendency to interpret the concepts of sustainability in the context of leadership rather than being prescriptive in finding ways to practically adopt sustainability concepts to enhance the efficiency of project activities.

In the Irish context project controls for sustainability has only progressed as far as diagnostic controls are concerned such as key performance indicators and monitoring such as project control tools and project health checks. However, there is agreement that using such tools does not accurately reflect the complete image of the project during its life cycle towards achieving sustainable goal outcomes.

Furthermore, in the Irish context, there is a significant awareness of executive support, and cross-functional support and the changing role of project managers and acceptance that they must supplement their traditional functions with broader awareness of sustainability knowledge and skills to meet today's professional demands. The modern project manager fulfils not only the traditional roles of project management but also must manage the project in the most efficient and effective manner with respect to sustainability.

5. Discussion

Insufficient knowledge of the way how to evaluate sustainability in project management could be connected with the overall situation in area of project management, where, based on the study in 2015, 2016 and 2017 the usage of project management methods and tools is mainly on the medium level (Taraba, 2018). In contrast, the situation in Ireland is more developed, sustainability is accepted in project controls with regard to project effectiveness and is required as a project manager competency. But still is there the space to improve it.

Ignorance or low awareness of the issue of sustainable project management is closely related to the issue of insufficient education in the field of project management (Kostalova, et al., 2018) and to the general expansion of knowledge in a certain area including the overall approach to knowledge management in the company (Doskocil & Smolikova, 2012).

An interesting observation is also the different understanding of the concept of sustainability. In addition to the meaning associated with ecological, social and economic responsibility, the connection sustainability with rules of national or European structural and investment funds' co-financed or financed projects appeared among the representatives of the non-profit and public sector, where the term sustainability refers to a set period of time during which the outputs of projects are to be used by the target group. Similarly, the term is also used by Vrchota et al. (2021).

In general, it can be stated that the incorporation of a sustainable approach into the project management processes or/and in outputs is currently insufficient. There is a lack of awareness of how sustainability evaluates in general and within project management. It is therefore possible to positively evaluate the effort to incorporate sustainability into the project management international standards (see Introduction). An example is the IPMA next version of IPMA Competence Baseline (ICB 4+) will include sustainability as one of the basic parameters of projects and required competence of project managers (Carboni, 2015).

6. Conclusions

Sustainability in project management is interwoven into dealing with stakeholder engagement, complexity and managing and balancing project related risks. The overall findings from this study are that while the integration of sustainability into PMMMs is slowly evolving and improving, there is much work to be done. The greatest limitation of this study was the limited time to carry out this study as only a certain level of analysis could have been undertaken. The researchers background in project management maturity research may have influenced results and findings on an unconscious basis, although all efforts were made to be neutral in this study.

The world is changing at an unprecedented rate, the project management sector must innovate and adapt to reflect the changing landscape of sustainability. The sector must strive to be proactive and lead genuine change in areas of sustainability and climate action, while prioritizing and balancing successful project outcomes.

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Project Management Practices in the Czech Republic. Is the Knowledge of Techniques and Methodologies Sufficient and Required?

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Abstract: The principles of project management are applied to the development activities facing most organizations today. Quality project management is a tool to successfully implement major changes in the life of a company, organization or public administration entity. Focused on the achievement of established goals and priorities, this method of management concentrates knowledge and skills for planning, organizing the preparation and subsequent implementation, and securing and effective use of resources of all kinds. In this context, the role of the project manager and his/her level of hard and soft skills is crucial. Where do Czech project managers stand in this field? Are Czech project managers sufficiently educated, using appropriate methodologies and using a wide range of software techniques and online tools? The paper aims to answer these questions through personal experience, i.e., field research and knowledge gained through several years of conducting seminars for the Ministry of Regional Development of the Czech Republic focusing on the education of applicants and beneficiaries of EU Funds. Results from seminars are expanded with project management surveys "Project Management Trends".

Keywords: applicant; beneficiary; EU Funds; Ministry of Regional Development of the Czech Republic; project manager; project management trends

JEL Classification: H43; M11; O22

1. Introduction

Some of the most commonly used terms today are the words project and the fourth industrial revolution – the technological revolution. A New Way Forward – call it disruption – or just the new normal. At a time of extraordinary change driven by new technologies, executive leaders from across the business, government and nonprofit organizations know that success depends on big, bold ideas. And they need people with the skills and mindset to deliver on those ideas with big, bold projects – or risk being left behind. The survey results for the 2020 year's Pulse of the Profession revealed an average of 11.4% of investment is wasted due to poor project performance. And organizations that undervalue project management as a strategic competency for driving change report an average of 67% more of their projects failing outright. With so much at stake – and so much in flux – organizations must rethink some fundamental questions: Why do we exist? What do we offer? Who will be tasked to do the work? The 2020 Pulse reveals a new way of doing

business. The beginning of a new decade is ushering in a world full of complex issues that require organizational leaders to reimagine not just the nature of work, but how it gets done. For the first time for Pulse, executive leaders identified which factors they see as the most important to achieve success in the future. The top three were: organizational agility (35%), choosing the right technologies to invest in (32%) and securing relevant skills (31%). Future-fit organizations are not only willing to reimagine their vision and purpose, but also eager to adopt new ways of thinking that will allow them to thrive in The Project Economy – a new terminus technicus. Change is as relentless as it is pervasive – from the impact of technologies like artificial intelligence to the clamour for greater social accountability to customers' ever-evolving expectations. Organizations that stick with the status quo risk not just treading water, but sinking. Now an essential business asset, change happens through projects. Organizations are undergoing a fundamental paradigm shift in which projects are no longer adjacent to operations but instead primary to how work gets done and problems get solved. In today's C-suite – and tomorrow's – it is the portfolio that disrupts, innovates, expands and thrives. In many ways, the organization is its projects – led by a variety of titles, executed through a variety of approaches, and focused unwaveringly on delivering financial and societal value. This is what PMI calls The Project Economy (PMI, 2020).

Yes, it is true and evident, projects move the world. Why does the reality of project practice not match the theoretical and methodological requirements? Only less than half of the companies consider the introduction of project management to be important:

- 67% – On average, that's how many more projects fail for companies that undervalue project management.
- 11% – That's how many resources companies waste on unnecessary processes associated with poorly implemented project management.
- 37% – So many project failures are caused by poorly defined objectives.

What can be done to prevent the project from falling into these statistics? Every project is unique in terms of the problems that arise, the priorities and resources assigned to it, the environment in which it operates, and the project manager's attitude and style to guide and control project activities. The success of a project thus depends to some extent on the skills of the project manager. What does it mean to be a great project manager? It is not about qualifications or degrees. It is not about merely delivering on a project manager's classic duties and responsibilities. But being a great project manager isn't just about tasks and timings. Some of the crucial project manager skills – the ones that will team the project manager feel valued, motivated, and trust – are divided into hard and soft skills.

The paper aims to describe the reality of project management, and the level of use of project manager competencies (hard, soft and technical skills). The results of the paper are a combination of the results of a survey entitled "Trendy projektového řízení, i.e., Project Management Trends)" among Czech/domestic and international managers, and own experience in leading and lecturing seminars for the Ministry of Regional Development of the Czech Republic (MRD CR), whose focus is the education of applicants and beneficiaries of EU funds. The paper is thus based on personal experience.

2. Methodology

After we have set the research question, we should also think about methods and techniques of data collection we will use in the field research. The use of qualitatively oriented methodological approaches is particularly significant for this research, as they can capture the phenomenon under study in more depth. First of all, this involves participant observation, various types of interviews, and content analysis of documents, but it can also be quantitative research in the form of a questionnaire. Of course, it is good to choose the methods according to the nature of the research problem in advance, but even here the methods may change in the course of the solution, i.e., during the fieldwork.

The methodology applied is the so-called field research. Field research – also field investigation, field study – these are terms used either as synonyms of empirical research, or to denote the field phase of empirical research, also in the sense of research in natural conditions in opposition to experimental investigation, or in the sense of fieldwork. Sometimes field research, and more likely its synonyms, is associated with a case study and direct observation. In this sense, it is particularly typical of social and cultural anthropology (Soukup, 2017). The paper is thus based on own personal experience, i.e., field research and knowledge gained through several years of conducting seminars for the MRD CR, whose focus is the education of applicants and beneficiaries of EU Funds.

Qualitative data are collected from personal observation and experience through a series of professional seminars sponsored and realized by MRD CR. Data in Table 1 characterize the series of seminars for the MRD CR personally lectured by one of the authors of the paper. Specifically, the seminars are EU Grants and Project Management, EU Grants and Financial Management, and EU Grants and Cost-Benefit Analysis. The data corresponds to the training period of 2019, 2020, 2021 and 2022 seminar cycles. The seminars are aimed at educating applicants and beneficiaries of EU funds. The questions in Table 2 are based on an evaluation questionnaire designed by MRD CR. Seminar participants' responses in questionnaire questions are captured on a five-level scale, representing school-like grades (1-best, 5-worst). The resulting statistics from the seminars are expanded with results of project management practice and conclusions from official surveys and investigations of the use of project management methods and techniques in the preparation and implementation of projects. Surveys “Trendy projektového řízení, i.e., Project Management Trends” are made by Czech company Easy Software and published online via EasyProject. Surveys “Trendy projektového řízení” are evaluated for the same years as the seminars, i.e., 2019, 2020 and 2021, except for 2022, for which results are not yet available or compiled.

3. Theory Versus Practice of Project Management

Project management is the planning of the steps that lead from the idea to the evaluation of the finished project. The goal of project management is the successful implementation of the project. However, it is not just about the well-known project triple-imperative, it is a set of several important activities in all phases (from initiation, planning through implementation to project evaluation).

Suppose you have a great idea for a project and you want to make it happen. What next? To make everything work, you first need to: define the goal of the project (what you want to achieve and why); define the purpose of the project (a measurable effect after the project is completed); identify the project management methods and techniques appropriate for your project; assemble a team led by a project manager (see how to do this and why the role of a project manager is important); plan a project timeline (by when you want to achieve your goal – deadlines for tasks, major milestones and project completion); allocate tasks (so everyone knows what to do and what they are responsible for); create a budget (in the initiation phase by estimating, in the planning phase by calculating); plan communication within the team (meetings, what form, how often, etc.), and determine the possible risks of the project (e.g., through a SWOT analysis); etc.

But what is the best way to transfer theoretical knowledge and methodological recommendations to the real practice of project managers? In this context, it is necessary to distinguish two project management lines, i.e., hard and soft project management. In project management, theory and practice exist concocted de-bate about hard versus soft project management merits. Besides hard and soft project management skills, we must talk about the technical skills of project managers. Nowadays project management is all about using the right tools and techniques. Having these two things in order can help each project manager manage the projects quickly and effectively. Many surveys have found that using the right project management tools and techniques can increase overall performance, productivity, and happiness levels at work.

The questions should be repeated. The easiest way is to implement project management software. Sure, it can be done in excel spreadsheets, emails and flipcharts, but it is not practical. Project management software can help organize work much more efficiently. In such a tool, users can assign tasks, communicate with all participants in the project, including freelancers, monitor budgets and deadlines, or even measure time spent on tasks and the entire project. What's great is that users can keep track at all times and go back to whatever was discussed. Users know exactly who's working on what, how long it took them, and what impact it had on the budget. So, no more pointless meetings and searching for information in a pile of handwritten notes. For example, what software and applications exist to make project management and all its steps easier and more efficient, address Melecký and Staníčková (2021).

4. Results and Discussion

Information about the knowledge of project managers in the field of project management, and information about their project competencies, i.e., whether hard, soft or technical skills, are obtained from two sources that complement each other, extend each other's results and thus support each other's conclusions. The first data source presents seminars for the MRD CR. The second data source is the survey “Trendy projektového řízení, i.e., Project Management Trends” by Easy Software/EasyProject.

4.1. Facts from Seminars for the Ministry of Regional Development of the Czech Republic

The first analytical part of the paper is based on personal experience, i.e., as mentioned above, field research and knowledge gained via ensuring education for the National Coordination Authority (MRD CR) is the central methodological and coordinating body for the implementation of programmes co-financed by EU funds in the programming period 2007–2013, 2014–2020 and 2021–2027. The primary source of information is data obtained from seminars for MRD CR via personal involvement, i.e., lecturing Czech applicants and beneficiaries of EU funds. These are Czech project managers in different project positions, working in different phases of the project life cycle, applicants and recipients themselves or their representatives, whether from the public or private sphere, as well as with different project experience – beginners or persons working in projects for several years or decades. The seminars were also attended by people who work in this field and the position of a project manager or consultant is their job (self-employed or employed by a consultancy company).

The seminars are EU Grants and Project Management, EU Grants and Financial Management, and EU Grants and Cost-Benefit Analysis.

- The aim of the seminars "EU Grants and Project Management" is to introduce the field of project management in the context of projects co-financed from EU funds in the Czech Republic, and to offer comprehensive information to strengthen project knowledge and skills for the preparation of projects co-financed by EU funds in the relevant programming period and their verification through practical examples. The target group of seminars "EU Grants and Project Management" are representatives of applicants and beneficiaries of EU funds who want to gain an overview of the theoretical and practical aspects of project management in the conditions of EU funds in the Czech Republic.
- The aim of the seminars "EU Grants and Financial Management" is to introduce the financial aspects of the preparation, planning and implementation of projects co-financed from EU funds in the Czech Republic in the relevant programming period, and to provide comprehensive information to strengthen theoretical knowledge and their verification on practical examples and exercises. The target group of these seminars "EU Grants and Financial Management" are representatives of applicants and beneficiaries of EU funds who want to gain an overview of the theoretical and practical aspects of financial management in the conditions of EU funds in the Czech Republic.
- The aim of the seminars "EU Grants and Cost-Benefit Analysis" is to introduce the theoretical and practical aspects of the preparation and procedure of Cost-Benefit Analysis (CBA) within projects co-financed from EU funds in the Czech Republic, and to provide comprehensive information to strengthen theoretical knowledge and their verification on practical examples and exercises. The target group of these seminars "EU Grants and Cost-Benefit Analysis" are representatives of applicants and beneficiaries of EU funds who want to gain an overview of the theoretical and practical aspects of cost-benefit analysis in the conditions of EU Funds in the Czech Republic.

The data corresponds to the training period of the seminars, i.e., data for the 2019, 2020, 2021 and 2022 seminar cycles. Concerning this time period, the seminars were held in two modes – live, i.e., offline (fully in 2019 and 2022), and more or less online (in 2020 and 2021, although some of the initial dates were held live and subsequently switched to a distance format due to the worsening COVID-19 epidemiological situation and announced government measures).

The seminars took place in 2019, 2020, 2021 and 2022 according to a single scenario. The location for the seminars were 13 regional cities, i.e., Brno, České Budějovice, Hradec Králové, Jihlava, Karlovy Vary, Liberec, Olomouc, Ostrava, Pardubice, Plzeň, Praha, Ústí nad Labem, and Zlín. All three seminars were always held in each regional city. The organizer of the seminars is the National Coordination Authority, i.e., the MRD CR. The seminars are organized by the Eurocentres of the MRD CR, which are located in the respective regional cities and provide information on EU funds, i.e. function of regional coordinator.

Summary statistical and contextual results related to the seminars are presented in following Tables 1 and 2. Table 1 provides a summary evaluation of the seminars, while Table 2 provides a detailed evaluation of each of the seminars in each year. In terms of the results, it is clear that although the seminars were conducted in 4 rounds, i.e., in 4 repetitions in 4 years, the interest in them developed more or less unchanged with time. The seminars were always held once a year and one thematic seminar was held in each regional city. Given the amount of repetition, one would expect interest in the seminars to decline over the years, but this was not the case. The results show that over the 4 years of repetition, a more or less similar number of participants have been trained in the seminars "EU Grants and Project Management" and "EU Grants and Financial Management" – around 990 on average. This is because many of them have attended these two seminars simultaneously, which are related in content and thus the applicant or beneficiary receives adequate information to identify, prepare and implement projects in terms of content and financial aspects. The interest in seminars is certainly due not only to the scope of this sector and the popularity of EU funding in the Czech Republic but also to the growing number of people involved, both applicants and beneficiaries, as well as project managers, advisors and consultants. Representatives of the public sector account for the largest number of participants, followed in equal measure by representatives of SMEs and NGOs.

The only seminar "EU Grants and Cost-Benefit Analysis" was held in 2020 and 2021, and the next series will follow in 2023. Taking into account the implementation of only 2 runs of this seminar, it is clear that the number of participants was the lowest. This is also because not all projects co-financed by EU funds require CBA. Another aspect is also the demanding nature of this topic on expertise both in terms of economic knowledge, financial literacy and overall awareness of measuring and evaluating the added value of projects.

The seminars EU Grants and Project Management, EU Grants and Financial Management, and EU Grants and Cost-Benefit Analysis are financed by the MRD CR from the Technical Assistance Programme and are therefore free of charge for the participants, which can also be an attraction and a competitive advantage compared to paid seminars of private companies, which are not cheap and also do not guarantee quality. The biggest

advantage of the seminars is undoubtedly the personality of the lecturer), who is rated as the greatest added value and professional in all evaluations, for the courses and the individual cities each year. This rating is not easy to maintain given the number of repeats of the seminars, and a stable "grade" speaks about the quality of the lecturer.

Table 1. Overall evaluation of seminars – statistical and content information

Seminar	EU Grants and Project Management	EU Grants and Financial Management	EU Grants and CBA
Basic data	Number		
Number of applicants	1,227	1,228	349
Number of arrivals	993	991	273
Number of questionnaires submitted	720	621	136
Information about participants – sector	%		
Non-governmental non-profit organizations	12%	11%	10%
Public administration	47%	43%	32%
Businesses – small and medium-sized	12%	12%	16%
Businesses – large	4%	4%	6%
Consulting and advisory companies	8%	8%	8%
Schools	8%	9%	9%
Other	8%	13%	20%
Questionnaire questions – course	Average (1–5 scale (1 best, 5 worst)		
Did the time, duration and venue of this seminar suit you?	1.38	1.41	1.59
Were you connected with the seminar?	1.27	1.23	1.32
How useful was the information for you?	1.56	1.54	1.58
How do you rate the performance of the lecturer?	1.16	1.12	1.22
Was the information clear to you?	1.20	1.30	1.55
Did the seminar meet your expectations?	1.52	1.49	1.63
How do you evaluate the level and processing of the teaching materials?	1.18	1.18	1.18
Open questions – course and more	The most frequent comments		
How was this event beneficial for you personally?	Absolute satisfaction. /Balanced ratio between theory and practice, concrete examples, tools and project examples from A to Z./Seminar on CBA. /Seminar focused on ISKP. /Seminar on public procurement. /Seminar on concrete examples of real projects according to operational programmes. /More days. /Unbeatable lecturer.	Overall satisfaction without reservations = especially the person of the lecturer. /Balance between theory and practice. /Problems related to a specific project from start to finish and examples of techniques. /Seminar on CBA. /Seminar on public procurement. /Seminar on public support. /Multiple days. /Distribution according to the level of expertise.	Another follow-up seminar. /Ideal and appropriate ratio of practice and theory. /Same great lecturer. /Nothing special, satisfaction. /More days (video recording).
Which part or topic was most useful to you?			
Which part or topic was least useful to you?			
What did you miss at the event?			
What would you recommend for the next event? *Note:* Considering the scope of the paper – only the most frequently mentioned comments have been selected.			

As far as the overall summary is concerned, it is evident that the courses are more than positively evaluated; moreover, the participants would appreciate an extension of these courses both in terms of duration and content in the context of other follow-up courses and topics. Last but not least, it should be mentioned that these results and evaluations are again clearly linked to the personality of the lecturer, who is also the project manager.

Table 2. Summary evaluation of seminars – statistical information

Seminar	EU Grants and Project Management				EU Grants and Financial Management				EU Grants and CBA	
Year	*2019*	*2020*	*2021*	*2022*	*2019*	*2020*	*2021*	*2022*	*2020*	*2021*
Basic data	Number				Number				Number	
Number of applicants	317	319	286	305	327	348	280	273	169	180
Number of arrivals	255	256	212	270	258	291	212	230	118	155
Number of questionnaires submitted	199	177	148	196	180	157	122	162	47	89
Information about participants – sector	%				%				%	
Non-governmental non-profit organizations	22%	4%	8%	15%	16%	9%	7%	13%	9%	11%
Public administration	54%	45%	43%	46%	50%	40%	42%	41%	38%	27%
Businesses – small and medium-sized	6%	17%	15%	12%	9%	16%	17%	5%	18%	14%
Businesses – large	2%	9%	0%	5%	2%	7%	0%	7%	5%	6%
Consulting companies	10%	4%	8%	11%	9%	7%	9%	7%	7%	9%
Schools	5%	10%	7%	12%	8%	9%	9%	12%	13%	5%
Other	2%	11%	19%	0%	6%	13%	16%	15%	11%	29%
Questionnaire questions – course and more	Average				Average				Average	
Did the time, duration and venue of this seminar suit you?	1.40	1.34	1.57	1.22	1.30	1.54	1.56	1.26	1.55	1.64
Were you connected with the seminar?	1.22	1.26	1.39	1.21	1.16	1.27	1.33	1.15	1.34	1.31
How useful was the information for you?	1.57	1.59	1.53	1.55	1.56	1.68	1.54	1.37	1.53	1.64
How do you rate the performance of the lecturer?	1.08	1.16	1.29	1.12	1.06	1.14	1.22	1.06	1.13	1.31
Was the information clear to you?	1.13	1.19	1.28	1.18	1.20	1.37	1.38	1.25	1.51	1.59
Did the seminar meet your expectations?	1.47	1.58	1.56	1.47	1.44	1.68	1.48	1.35	1.62	1.65
How do you evaluate the level and processing of the teaching materials?	1.15	1.20	1.23	1.13	1.13	1.30	1.20	1.11	1.09	1.27

4.2. Facts from Surveys Project Management Trends by Easy Software/Easy Project

The resulting statistics from the seminars above are supplemented by project management practice, i.e., with the results of official surveys and investigations of the use of project management methods and techniques in the preparation and implementation of projects. Surveys "Trendy projektového řízení, i.e., Project Management Trends" are made by Czech company Easy Software and published online via EasyProject (2019; 2020; 2021). Surveys "Trendy projektového řízení" are evaluated for the same years as the seminars, i.e., 2019, 2020 and 2021, except for 2022, for which results are not yet available (since it is early 2023). Recent years have been full of changes for all companies and their employees. The introduction of telecommuting brought with it the need for greater trust in teams and new work processes. Constant changes to budgets and layoffs as well as new hires. The turbulent year 2020 has put a thick line behind what was normal until then. A survey of project managers provides insight into the changes and practices of project management in the years before, during and after the covid pandemic, i.e. 2019, 2020 and 2021.

- Project Management Trends for 2019
  - Not only large and medium-sized companies but also small companies or freelancers feel the need to manage their projects in a different and better way than through sticky notes or excel spreadsheets.
  - Companies want to integrate project management tools into their software systems to link them with communication channels – online project management tools.
  - In the context of the Czech Republic, there is often talk about the need for robotization and automation of production. Here too, project management is useful: it brings automation of resource management, production planning, and service and even helps automate sales and marketing (EasyProject, 2019).
- Project Management Trends for 2020
  - Home office, team discipline, budget and profitability changes, layoffs and hiring, switching to more efficient work management software, but also "self-motivation issues". The most common challenges, and obstacles but also positives that the pandemic year 2020 brought in project management.
  - Even though around half of Czech respondents did not rate 2020 well, this is still a relatively optimistic result given what many traditional industries have experienced. Up to about 90% of managers from industry and logistics perceived 2020 as worse than expected and about 10% of managers perceived it much better. The comparison with global managers is interesting: almost 65% of them rated 2020 as a year when everything turned out as expected or even better or much better.
  - Many project managers were afraid of the transition to the home office. Those who were "first timers" in 2020. More than a third saw a 10-49% drop in productivity. Managers from companies working from home were already established and were the most positive about the impact of the home office on team productivity. Almost half of the managers did not perceive any change in productivity, which can be

considered a success. Foreign managers are a bit more positive: one-third perceived an increase in home office productivity (in the Czech Republic it was only 13%).

- How were the projects managed from home? Badly. Only a third of Czech project managers rated remote team management positively. There are, of course, more reasons, but the most common was problems with team discipline. It is clear from the results and the current reality that remote management has become part of many organizations. As is the case abroad – up to two-thirds of managers have no problem with "remote management" or even evaluate it positively.
- How has the pandemic crisis affected the profitability of projects? As many as a third of Czech and global managers said nothing. The drop in profitability was also almost the same in our country as among foreign respondents. However, it is different with its increase. It was 40% more frequent in foreign projects, where about one-fifth of managers reported it. Deadlines and project delivery are an "old familiar issue" even without the corona crisis. However, according to the survey results, up to three-quarters of project managers in the Czech Republic delivered their projects late, which is quite a terrible result. All the more so when we compare it with foreign countries, where just under half of the managers had a similar problem and experienced accelerated project delivery three times more often.
- The question of whether the crisis has brought something of business interest to the organization – perhaps unexpected business opportunities – may sound like a provocation. More than half of the executives were able to land unexpected new projects as a result of the events of 2020. This is certainly due in part to the fact that a significant number of respondents were from IT backgrounds, where 2020 was at least as much an opportunity as a threat. 2020 ruined the plans of the other half of the companies in which they lost projects unexpectedly. Compared to foreign executives, we were worse off in the Czech Republic in terms of findings and losses.
- The busiest department of 2020 was HR. Although pay cuts were 4 times more common than pay increases in 2020. Mid-sized companies cut to pay the most, while also laying off the least. Large firms cut pay the least often but are laid off the most. What effect has this had on bonuses and salaries? Respondents were 4.5 times more likely to see a decrease in bonuses than an increase. About half of the managers say that nothing has changed at all when it comes to bonuses and salaries.
- The main message of COVID-19-year 2020 and the pandemic crisis: In an emergency, you know a friend – in a crisis a good tool for project management! Companies and organizations around the world use a lot of different project management software, and about 40% of teams in the Czech Republic and abroad eventually started working with new software. Czech managers tended to increase the total number of software, those abroad tended to replace old tools with new ones (EasyProject, 2020).

- Project Management Trends for 2021
  - Year of acceleration – the year 2021 was stronger compared to 2020. 7 in 10 executives rate 2021 better than 2020, regardless of their industry or company size. The country where the company operates does not change this fact – both domestic

and international managers agreed. For 62% of Czech companies, 2021 is even ahead of 2019 in terms of turnover. Only a third of foreign companies can say the same. The other third of foreign firms reported worse results than in 2019.

  - Quality people are the key to success – projects were unfinished mostly due to a lack of human resources. Even though one-third of domestic companies managed to recruit a new workforce, quality people are still a scarce commodity. Companies see the solution to this problem primarily in better planning and more effective teaming based on individual project needs. It is important not to underestimate the selection of individual team members and to monitor how well they work together.

- Based on the above facts about the reality of project management in the Czech Republic, it is clear that Czech project management practice confirms that managing projects remotely is not problematic, but quite the opposite. Most Czech companies were better at delivering projects in 2021 than in 2020. In the first year of the pandemic, two-thirds of managers could not identify with managing projects remotely. However, 2021 saw a leap year, when 76% of project managers were comfortable with remote management. Abroad, as many as 81% of respondents took remote working as a natural part of the job. During 2021, Czech companies started working on improving project culture and want to continue doing so. This is mainly due to the creation of specialized teams and more frequent involvement of company management in projects (EasyProject, 2021).

5. Conclusions

Back to the top of the paper. What is the future of project management: how to prepare for technological and societal changes? Technology, the economy and society are evolving faster and faster and this will also affect a field such as a project management. According to Forbes, the way projects are organized will change soon mainly as follows (Brownlee, 2019):

- Agile methods will become more common: Companies that can adapt to rapid developments evolving in budget, schedule etc. have a big advantage.
- Artificial Intelligence (AI) will dominate processes: 85% of Chief executive officers worldwide believe that artificial AI will significantly impact business in the years to come. But at the same time, it is hard to find qualified staff to introduce at least some kind of AI into the business. This sounds like a challenge for project managers – a basic understanding of robotics, data science and other areas of AI.
- More emphasis on empathy and relationship skills for project managers: empathy is the most important trait for team leaders and will be increasingly emphasized. Take an interest in team members – what they are feeling and whether their sudden drop in productivity is related to personal issues.

Everyone manages projects, even if not everyone realizes them. A project is a fundamental tool for managing the changes that happen to all of us. But everyone - individual and company alike – has different needs. A small team or individual handling units of projects at the same time needs a simpler tool to keep track of tasks, time worked and project income and costs; on the other hand, a company with 50 or 100 employees handles dozens or

hundreds of smaller or larger projects simultaneously – some at a strategic level, others at an operational level. Here, prioritization of projects is already necessary, linked to resource utilization and capacity management – ideally all transparent throughout the whole company, otherwise, it is common that operational issues eat up resources for strategic projects, which then do not move forward, and the company loses competitiveness. And that's not all, these activities are commissioned, coordinated, and communicated by someone – person – project manager. You need to know and, more importantly, be able to apply both the hard and soft competencies of a project manager, and ideally all of them and combine them well, i.e., a mix – for more information see e.g., Melecký and Staníčková (2021).

In conclusion, although this is obvious and familiar, it is not too much to repeat: How do we know if we have set up project management correctly? By completing a project that: met its objectives; met a predetermined measurable purpose; is not over budget; met the schedule; eliminated potential risks; made effective use of all resources; and has a positive impact on society. Generally, for all projects and times. The recipe for successful project management. Trust in the team and accountability of individual members is an essential ingredients for a long-lasting team. In addition, need to think about regular feedback to help the team move forward. And what does reality say? What is the actual practice? Projects were done by the heroics of individuals with no standard methodology.

The biggest weakness and at the same time the biggest challenge of Czech project practice is the lack or insufficient certification of project managers. By obtaining the certificate, the project manager demonstrates that he/she has the appropriate expertise in project management and can work as a member of a project team or as a project coordinator. This is the area in which the most improvement is needed. Another problematic area is the ethics of the project manager, which no certification can ensure.

Conflict of interest: none.

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Knowledge Sharing among University Students: Current Practice and Perspectives

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Abstract: Knowledge management and the process of knowledge-sharing gained even greater importance last few years due to the distance cooperation environment. A specific area within the topic is sharing of knowledge between university students as this approach and experience can be further reflected in their future employment. The paper aims to bring a literature review to analyse university students' knowledge-sharing behaviours and patterns and to test the findings on primary data of a selected group of university students. For the data collection, the online and paper questionnaire survey method was used, and descriptive statistics and selected tested hypotheses were used for their analysis. The paper also highlighted tools for knowledge sharing among students. The paper's major findings revealed that students are open to knowledge sharing in class and a study group. They are used to using online tools for knowledge sharing, and they have mainly one preferred. What motivates students the most to share knowledge is belongingness to the group. The study concludes that it is essential to support a knowledge-sharing environment at universities and encourage students to knowledge-sharing as it is a vital factor for their employment.

Keywords: knowledge sharing; learning; online environment; questionnaire survey; university students

JEL Classification: A22; D83; I23

1. Introduction

Knowledge management literature focused on knowledge sharing mainly discusses this topic among employees or organisations' members. Only a limited number of studies have investigated the knowledge-sharing practices of higher education students.

The importance of encouraging knowledge-sharing among students for employability and quality assurance is supported by the fact that students are an essential segment of society and the main driver of future growth and development. Therefore, there is a need to develop a better understanding of this topic by undertaking dedicated research on knowledge-sharing among university students. Furthermore, understand the multiple rationalities underlying these arrangements (Gamlath & Wilson, 2017; Yuen & Majid, 2007). For higher educational institutions, it is of the essence to encourage a collaborative learning environment to support learners' performance and promote knowledge acquisition. Collaborative learning (CL) is an educational teaching and learning approach involving learners working together to solve a

problem, complete a task, or create a product (Smith & MacGregor, 1993). This helps to develop a culture and attitude of knowledge sharing among university students. E-learning as an online environment has changed the learning approach by offering students and academics the ability to acquire and disseminate knowledge anytime and anywhere (Al-Emran & Teo, 2020; Salloum et al., 2019). Students' active and voluntary sharing is vital to successful collaborative learning. It means fostering a positive culture of knowledge sharing among students is essential. The trend of using social media in the education context is growing fast, particularly in student collaboration, as social media has the potential to increase users' knowledge through a facilitated knowledge-sharing environment (Rasheed et al., 2020). Students have been using social media for several purposes, mainly for collaborating, interacting with others, and searching for information.

Even though knowledge-sharing is known to positively affect both the holder and the recipient, sharing is sometimes not easy as various knowledge-sharing barriers exist (Ong et al., 2011). Students may adopt a mentality of knowledge hoarding because they consider such a practice a competitive advantage over other students. This is especially true if good academic performance has been accompanied by little academic rewards (e.g., scholarships), better job opportunities, or even the possibility of continuing higher education at more reputable universities in the future (Chin Wei et al., 2012). Moreover, university students will often be the future leaders in knowledge. As (Kalu et al., 2019) pointed out, knowledge sharing in the university environment incentivises further employees to share their knowledge to improve the group's performance and competitive advantage. Identifying factors that lead to not sharing with others would help to understand better and effectively manage the knowledge-hiding behaviour of students (Garg et al., 2021). The paper aims to map the current knowledge-sharing situation in higher education from the literature review and demonstrate findings in the behaviour of university students in a case of a selected sample of business students in the Czech Republic.

2. Literature Review

According to Fullwood et al. (2013) and Gamlath and Wilson (2022), universities play a crucial role in the knowledge economy by creating knowledge through research. They transmit it by teaching activities, disseminating research findings, and collaborations between industry and government. Knowledge generation and learning processes at both individual and organisational levels has transformed the university into a knowledge-intensive organisation. The supply of higher education graduates should respond to the global labour market needs (Bratianu et al., 2011; Brouwer and Jansen, 2019). According to Castaneda and Cuellar (2021), problem-solving, creative thinking, teamwork, decision-making, communication, negotiation, critical thinking, leadership, and creativity are some of the most essential skills in business education that can be developed through knowledge sharing.

The knowledge management (KM) is known as recognising, sharing, using, and practising knowledge within an organisation (Choi et al., 2020; Xuan, 2020). Another author identifies knowledge management as the creation, transfer and application of knowledge (Spender, 1996). Knowledge management depends on a number of core competencies, including

knowledge acquisition and storage, knowledge application, knowledge sharing, and knowledge creation (Alavi & Leidner, 2001).

Knowledge sharing (KS) is the process by which team members share task-related ideas, information, improvements, and suggestions with one another (Eze et al., 2013). Based on Han et al. (2022), knowledge sharing is a complex social interaction process that draws on formal and informal and mutual learning processes between individuals. It is a behaviour of giving knowledge to others and receiving it from others. Doing so requires the student or group of students to interact with each other through face-to-face or non-physical contact means (Chin Wei et al., 2012). Knowledge sharing is an everyday activity of students because they tend to exchange information through daily personal interactions with their peers and academic instructors (Ong et al., 2011).

As Gamlath and Wilson (2022, p. 6) stated: Recent advances in technology and the increase in the importance of online and blended approaches to learning and teaching have made possible the design of innovative approaches to knowledge sharing within the curriculum. Collaborative learning through group projects and peer assessment is one of the ways universities have integrated knowledge sharing into their curricula. The knowledge that students create and share through these collaboratively based curricular activities is directly related to the unit's learning objectives, program goals, and graduate attributes and is, therefore very much explicit (Gamlath & Wilson, 2022). In addition, there are concerns about dysfunctional behaviour in groups and student concerns about the fairness of group assessments. Group assessment tasks are a particular case because they often involve working together with students with different motivation levels and abilities. Assigning a common grade to all group members encourages high-achieving students to take on a non-proportional share of the task load while encouraging group members who are not sufficiently engaged in the topic (Hannaford, 2017). Students' ability to share knowledge is linked to the corporate world's interest in recruiting employees who can communicate information to others in a clear form (Begoña & Carmen, 2011; Ghadirian et al., 2014). Moreover, knowledge sharing is an essential aspect of universities' graduate skills and employability strategy, where the employability of graduates is a significant determinant of a university’s success (Collet et al., 2015).

Knowledge sharing behaviour of university students has been examined in several studies. Hassandoust et al. (2011) examined behavioural factors concerning virtual knowledge sharing among Malaysian Multimedia University students. Findings of the study showed that trust, expected reciprocal relationship and willingness to share knowledge are significant indicators of an individual's intention to share knowledge. Moreover, students who participated in the virtual knowledge-sharing activity were motivated to contribute knowledge to others due to their positive attitude towards knowledge-sharing and institutional factors. Brouwer and Jansen (2019) investigated various determinants of knowledge sharing and their effects on knowledge-sharing among Dutch`s university psychology students. Results of the study showed that altruism, trust, and belongingness indirectly influence the personal benefits of knowledge sharing through social interaction.

Other authors have examined the impact of various social networking tools, including chat and discussion, content creation, file sharing and entertainment on knowledge sharing. They concluded that chatting, discussions, and file sharing were significant predictors of knowledge-sharing, whilst content creation and entertainment had a marginal effect on knowledge-sharing (Eid & Al-Jabri, 2016). Castaneda and Cuellar (2021) stated in their study that knowledge sharing in business education is a growing research topic and identifying the best tools for sharing and building knowledge in the education process of business education students is ongoing. In the results chapter there are described the most used online tool by Czech students on the example of the Faculty of Economics. Table 1 summarises selected studies that pay attention to knowledge-sharing among university students.

Table 1. Knowledge sharing among university students – secondary data examples (own elaboration based on Brouwer and Jansen (2019), Dezdar (2017), Eid and Al-Jabri (2016), Hassandoust et al. (2011), Kalu et al. (2019), Ngoc Hoi (2021), and Yuen and Majid (2007))

Author and year of the research	Respondents	Key findings
Yuen and Majid (2007)	180 undergraduate students from three public universities in Singapore	Respondents indicated positive attitude towards knowledge sharing and appreciated its importance in peer learning.
Hassandoust et al. (2011)	250 students from various faculties of the Cyberjaya campus of Multimedia University Malaysia	Trust, expected reciprocal relationship and willingness to share knowledge are significant indicators of an individual's intention to share knowledge.
Eid and Al-Jabri (2016)	308 tertiary students of the University in Saudi Arabi	Chatting and discussions and file sharing were significant predictors of knowledge sharing.
Dezdar (2017)	160 postgraduate students in Iranian public universities	Humility, interpersonal trust, reputation, self-efficacy and enjoyment of helping others are factor influencing knowledge-sharing of the students.
Brouwer and Jansen (2019)	183 Dutch university students of the first-year psychology	Altruism, trust, and belongingness indirectly influence the personal benefits of knowledge sharing
Kalu, Useido, Chidi-Ka;u (2019)	27 students of Electrical/Electronic Engineering Technology Students	Social media channels are the most effective for knowledge sharing, trust motivates students in sharing knowledge. Low self-esteem and illiteracy are the barriers.
Ngoc Hoi (2021)	399 higher education students at university in Southern Vietnam	Facebook has pedagogical potential and provides the pedagogical resources students need to engage in knowledge sharing

3. Methodology

The authors of the paper present the topic of knowledge-sharing in the university environment in the literature review and primary data of a selected Czech university students. The data used for research and further analysis was collected through an online questionnaire in Survio. We used a combination of CAWI method (Computer-Assisted Web Interviewing) and printed questionnaires to map the topic of knowledge sharing among university students. The population consisted of all students of the Faculty of Economics of the Technical University of Liberec, the Czech Republic. The survey was conducted among students studying for bachelor's and master's degrees. The presented results concern only full-time students.

The questionnaire was created based on systematic literature review findings and a pilot qualitative survey done as a semi-structured interview. It consisted of 28 questions, which were available either electronically in the Survio platform or physically during selected lessons. The total number of participating students was 379, and the overall return rate was 57.3%. The survey was conducted during the months of May and June 2021.

Descriptive statistics were used to analyse the data, and selected hypotheses were tested. The data were tabulated into frequency tables and graphically portrayed. Each response scale was also characterised using selected characteristics of the central tendency (mode, median, arithmetic mean) and variability (standard deviation, coefficient of variation). These characteristics are presented, for example in Hindls et al. (2018). Spearman's test of independence was used to test the presented hypotheses, which is suitable for examining relationships between ordinal variables. The value of the Spearman coefficient can be calculated according to (Pecáková, 2011):

$$r_S = 1 - \frac{6\sum_i^n d_i^2}{n(n^2-1)} \quad (1)$$

where $\boldsymbol{d_i^2}$ are the differences of the ordinal numbers of the ordered values of the variable X1 and the variable X2, n is the sample size.

The null hypothesis of the Spearman test assumes that the two ordinal variables are independent. IBM SPSS Statistics Base statistical program was used to test the observed hypotheses.

4. Results

The results of the analyses that arose from the analysis of the questions relevant to the topic discussed in the introduction of this paper are presented in this chapter. First, the authors focus on the individual questions of the questionnaire, and in the next section, the hypotheses are evaluated. In the introduction, it is also necessary to explain some of the terms that appeared in the questionnaire. ”Year of study” (in other words “class” means a group of students who have started the current study program together with the respondent). ”Study group” indicates one or more students with whom the respondent cooperates during the study. Within the group, the respondent cooperates, complements each other, and works on a common result. The study group does not have to be the same people during the entire study program or in all studied courses.

4.1. Main Outcomes of the Questionnaire Survey

There were several statements in the questionnaire. The overview of them is given in the Tables 2 and 3. The first statement analysed (marked as 6_1) is: "My study program facilitates knowledge sharing between students". The responses for this and all the other statements are Likert scale values, where 1 means strongly disagree, and 5 means strongly agree. As seen in Table 2, the largest number of students chose a neutral answer of 3. However, a larger proportion of students strongly or rather agree with the statement (40.4%) than those who strongly or rather disagree (22.7%). It can therefore be concluded that the study programmes are well adapted to knowledge sharing.

Table 2. Frequency table for the analysed statements – relative frequencies in %

Scale	6_1	7_1	7_2	7_3	10_1	11_1	11_2	11_3	12_1	13_1	13_2	15_1	15_2	15_3	15_4	15_5	15_6
1	4.5	5.5	4.2	8.2	4.7	4.5	2.9	3.4	8.7	6.9	6.1	8.2	10.0	8.7	19.5	22.2	15.0
2	18.2	8.2	11.3	15.8	11.3	8.4	9.0	14.0	4.5	11.6	5.5	10.6	18.2	16.1	21.6	21.4	26.9
3	36.9	15.0	23.5	29.8	24.8	9.5	14.2	24.8	4.7	24.3	15.6	25.9	25.9	26.6	30.1	27.2	28.8
4	30.6	29.8	32.5	27.2	39.6	25.1	28.5	33.2	17.2	27.2	23.7	31.1	24.3	25.1	15.0	15.3	16.9
5	9.8	41.4	28.5	19.0	19.5	52.5	45.4	24.5	64.9	30.1	49.1	24.3	21.6	23.5	13.5	14.0	12.4

Table 3. Values of selected descriptive statistics for the analysed statements

Statement	Arithmetic mean	Mode	Median	Std. deviation
6_1	3.23	3.0	3.0	1.003
7_1	3.93	5.0	4.0	1.177
7_2	3.70	4.0	4.0	1.123
7_3	3.33	3.0	3.0	1.187
10_1	3.58	4.0	4.0	1.070
11_1	4.13	5.0	5.0	1.160
11_2	4.04	5.0	4.0	1.102
11_3	3.61	4.0	4.0	1.101
12_1	4.25	5.0	5.0	1,264
13_1	3.62	5.0	4.0	1.217
13_2	4.04	5.0	4.0	1.188
15_1	3.53	4.0	4.0	1.198
15_2	3.29	3.0	3.0	1.267
15_3	3.39	3.0	3.0	1.245
15_4	2.82	3.0	3.0	1.290
15_5	2.78	3.0	3.0	1.328
15_6	2.85	3.0	3.0	1.230

The next statement was "I am willing to share knowledge within my year of study (class)" (marked as 7_1). The range of responses is the same as in the previous case. As can be seen in Table 2, the highest proportion of responses is recorded for answer 5, which indicates strong agreement (41.4%) and 29.8% of students rather agreed. Thus, in summary, 71.2% of students indicated agreement with the statement, which means that most of them are willing to share knowledge within the class.

Another statement (marked as 7_3) was focused on finding out whether the class environment made students share their knowledge more with other students. As we can see in Tables 2 and 3, the most common response was neutral 3 (29.8%). However, if we look at the

proportion of those who gave some degree of agreement with the statement, we can see that there are significantly more of them than those who chose some degree of disagreement as their response (46.2% vs. 24.0%). Thus, the class's learning environment appears to be some motivator to share knowledge, although not significantly.

The most frequently occurring answer for the statement "My study programme facilitates group work" (marked as 10_1) is 4 - rather agree (39.6%). The answer 5 is also quite well represented; together with 4, it makes up 59.1% of the total number of answers (compared to 1+2, which is 16.0%). Thus, we can summarise that most students believe that their study programme supports or rather supports group work.

For the statement "I am willing to share my knowledge in my group" (marked as 11_1), the most frequent answer was 5 - strongly agree (52.5%). Together with answer 4, it makes up a significant 77.6% of the total responses. Thus, students are strongly willing to share knowledge within their study group. Let's compare these results with the willingness to share knowledge within the class. This willingness to share knowledge is much higher within the smaller study group than within the large group, which is the class - the difference can be seen in Figure 1 below.

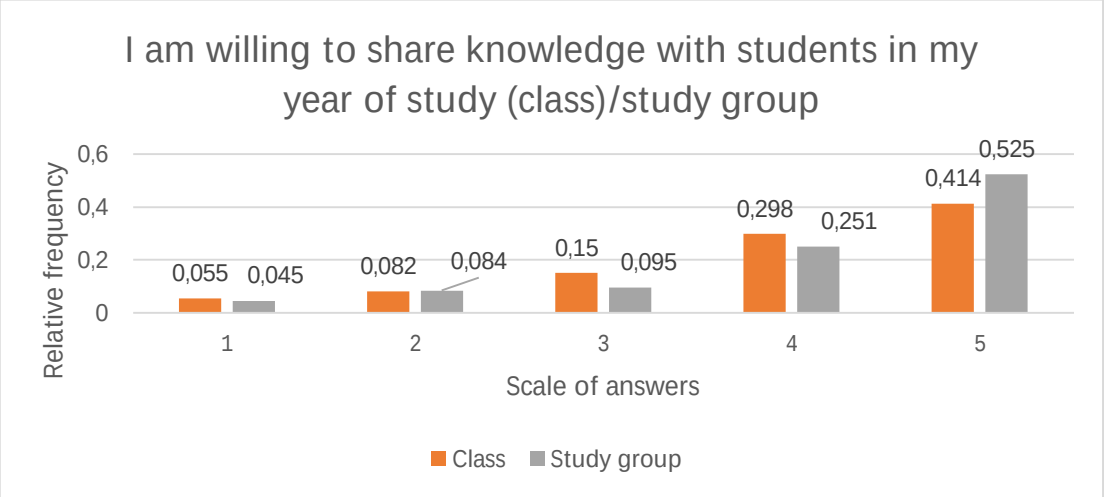

Figure 1. Comparison of willingness to share knowledge within a class/study group

The statement "In my group, it is common to share knowledge" (marked as 11_2) was the one that students completely agreed with most (45.4%). If we add to this the proportion of those who rather agreed, we get a respectable 73.9%. Again, most examined students are used to sharing knowledge with each other within their study groups. The other statement is "My group environment has made me increase my knowledge sharing" (marked as 11_3). The most frequent answer is 4 - rather agree. Together with answer 5, it makes up 57.7% of the responses. Thus, a supermajority of students has an environment within their study group that motivates them to share knowledge.

For the statement "I am willing to share knowledge with students I know well" (marked as 12_1), the most frequent answer is 5 - strongly agree (64.9%). Together with the value of 4 (rather agree), it represents 82.1% of the answers. Thus, the great majority of students are

willing to share their knowledge with those students with whom they are well-known. The median and arithmetic mean values are very high, as shown in Table 3.

The other two statements focused on determining whether it is common for a student to share knowledge within his/her class/group (marked as 13_1 and 13_2). The most frequent answer in both cases is 5, i.e. I strongly agree with the statement "I usually share knowledge with students within my class/group". The median value in both cases is 4. A slight difference between the perception of the class and the group can be observed in the value of the arithmetic mean, where the mean response for the class is 3.62, whereas for the group, it is 4.04. The differences in the responses for the two statements are shown in Figure 2. It can also be seen from the frequency distribution table (see Table 1), wherein a cumulative way, the answer 4+5 for the class makes up 57.3% of the responses. At the same time, for the group, it is 72.8%.

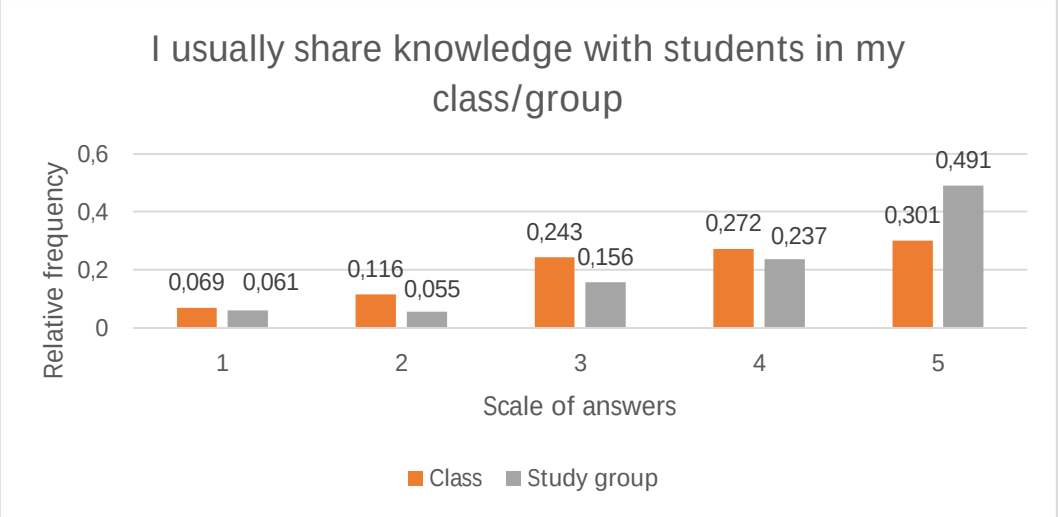

Figure 2. Comparison of knowledge sharing habits within a class/study group

The following six statements relate to the willingness to share knowledge during a coronavirus crisis. The first of these statements says: "My study program facilitated knowledge sharing during the corona situation" (marked as 15_1). The largest number of students chose to answer 4 (I rather agree – 31.1%). A total of 55.4% of the respondents somewhat agreed with the statement. Thus, more than half of the students felt that their study programme rather or completely supported knowledge sharing during the coronavirus crisis.

The most frequently occurring response for the statement “It is more knowledge sharing in my class during the corona situation" (marked as 15_2) is 3. The median value is 3, and the arithmetic mean is slightly greater than 3. This could be interpreted as that in some aspects of the study, the coronavirus situation has caused more intensive knowledge sharing; in others, knowledge sharing was already occurring before, and the coronavirus situation has not affected anything new. The third statement in this group is, "It is more knowledge sharing in my group during the corona situation" (marked as 15_3) we can see that the most frequent answer here is also 3, the median is also 3, and the arithmetic mean is 3.39. This means that, again, in some aspects, there was a real increase in knowledge sharing within the group; in

others, there was no change. However, a higher proportion of those who agreed or rather agreed with the statement (48.6%) than those who disagreed or rather disagreed (24.8%).

The fourth statement in this group is the statement, "The corona situation has changed my intention for knowledge sharing in my class" (marked as 15_4). It is also interesting to note that here the cumulative proportion of those who disagreed or strongly disagreed with the statement (41.2%) exceeds those who strongly or strongly agreed (28.7%). The result can be explained in a similar way to the previous statements. In some cases, the willingness to share one's knowledge with students changed over the class; in others, there was no change.

The penultimate statement in this group is the statement, "The corona situation has changed my intention for knowledge sharing in my group" (marked as 15_5). The response that is recorded most frequently is again 3. The results for this statement replicate quite well the results for the previous statement, which relates to sharing knowledge with students in the class. Thus, no significant difference in responses is seen here. The statement "After the corona situation, I prefer to do my study work more individually" (marked as 15_6) had the most frequent response of 3. However, it is interesting to note that total disagreement or some disagreement with the statement is recorded by 42% of respondents. In contrast, complete or partial agreement with the statement is recorded by only 29.3% of respondents.

Another analysed question focused on the frequency of use of different online communication tools in the study context. Here, the response scale for each tool was set so that 1 meant using the tool daily, value 2 meant using the tool quite often, value 3 meant using the tool sometimes, value 4 meant using the tool rarely, and value 5 meant not using the tool at all. The percentage of responses for each online communication tool is shown in Table 4, and a list of selected descriptive statistics for each online communication below further supplements the information.

Table 4. Frequency table for the question on frequency of use of different online communication tools – relative frequencies in %

Scale of Answers	Google Meet	MS Teams	Zoom	E-mail	Social Networks	Skype	Slack	Instant Messaging
Daily	48.0	3.4	1.8	53.6	71.0	2.4	0.8	2.9
Quite Often	31.7	6.3	4.2	25.6	17.2	1.1	0.5	1.3
Sometimes	7.1	7.9	7.7	14.8	4.0	4.5	1.6	1.3
Rarely	6.9	46.4	60.7	1.6	3.4	69.1	76.5	74.3
I do not use it at all	6.3	35.9	25.6	4.5	4.5	23.0	20.6	20.1

The presented data show that the most used online communication tool is social networks (WhatsApp, Messenger, etc.), followed by email and then Google Meet. For all the remaining tools, an average answer greater than 4 is recorded, meaning use rarely or not. Using of Google Meet also originates from the university's online communication culture. Google tools were selected during the Covid-19 pandemic as a common platform for communication for respondents.

4.2 Verification of the Hypotheses Presented

Selected analysed statements were further tested, and results are presented in this subchapter. As mentioned above, one of the research team's hypotheses was that the more the study programme facilitates collaboration, the more students feel affiliated with their class or group. To test these hypotheses, the statements "My study programme is facilitating knowledge sharing among students" and " I feel a strong sense of belonging with my class/group" were used. The responses for both statements are Likert scale values – thus, both can be classified as ordinal variables.

First, the hypothesis concerning belonging to the class (year of study) was tested. The Spearman's rank correlation coefficient was calculated, which is 0.36, and its significance was tested. The p-value was less than 0.01 (specifically 5.0361·10-13). Therefore, the hypothesis of independence of the two scales was rejected. The value of Spearman's coefficient proves that the more the study programme facilitates collaboration, the more students feel an affiliation with their class. However, this dependence is rather weaker.

If we look at the test that concerns the study group, here the P-Value is also less than 0.01 (specifically 2.7759·10-20). Therefore, we also reject the null hypothesis of no relationship between the variables analysed. The value of Spearman's coefficient here is 0.450, indicating a moderately strong relationship. Thus, here too, we can conclude that the claim that the more the study programme facilitates collaboration, the more students feel an affiliation with their group has been proven. This dependence is stronger than in the case of belonging to the class. In fact, this trend is evident in all the responses related to the class and the group.

5. Discussion and Conclusions

Kalu et al. (2019) state that thanks to knowledge-sharing, students could learn to formulate ideas and opinions more effectively by communicating them with others. This helps to prepare students for their future careers. Therefore, it is important to pay attention to the knowledge-sharing and supportive environment at universities to effectively prepare future graduates to manage and share their knowledge in their future jobs.

The more the students feel cohesiveness with the class or group, the more they are willing to share their knowledge. The collaborative learning approach within the class even more supports it. Presented data confirmed that students feel a sense of belonging when the study program is set up for collaboration and supports it. There is more belonging in the study group than in the study year, and the belongingness and willingness to share are much stronger with the group. Online tools were confirmed as frequently used by students, and the choice of the tool depends on the university environment and culture. Therefore, the most preferred tool by respondents was identified as Google tools.

Overall, knowledge-sharing was tested for the Faculty of Economics, and the results confirmed the findings. However, the authors are aware of the limitations of the study. Results can only be generalised for the other university students except for the population of students from the Faculty of Economics, TUL. The data show that if they can manage and share knowledge already during their education, they will be better prepared for cooperation in the company. Moreover, if the students feel a sense of belonging to the group and study year, this

could also help deepen the relationship with the university. It is essential to support a knowledge-sharing environment at universities and encourage students to knowledge-sharing. The topic gives the potential for further research, and the authors extend their work and data collection to the international environment.

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Circular Activities of Major Norwegian Cities Communicated through their Websites

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Abstract: The transition to a circular economy entails the creation of new business models, brings new social changes, but also faces a number of challenges and opportunities to meet the goals of sustainable development. The importance of the circular economy has been growing in recent years also at the municipal level, and many large cities are in the phase of transition to a circular city. This paper presents the results of research aimed at identifying the circular activities of selected Norwegian cities, which are communicated through their official websites in order to analyze and evaluate the extent and level of circulation within the implemented activities. The aim is to describe the results of this research, to describe the activities implemented, the level of their communication, the circulation strategies used and to identify examples of good practice for use in other cities. The intention was to obtain at least a general overview of the current state of support for circular activities by municipalities in Norway, i.e. a country with an inspiring approach to the environment. The study shows that all monitored Norwegian cities are dedicated to the concept of circular economy, regardless of their size, the most frequently circularity strategy is Reduce.

Keywords: circular economy; circular city; circular strategy; municipality; Norway

JEL Classification: Q01; Q5; R11

1. Introduction

Sustainable development is receiving attention from academics, politicians, various organizations and the public, the set of Sustainable Development Goals – SDGs, have been influencing strategies and policies at international, national, corporate and municipal levels for many years. To achieve them, new approaches are being investigated and new topics are coming to the fore, including the circular economy (Guldmann, 2020). This new concept reaches all levels of the economy, with an increasingly important role also at the level of local government (Dagiliene, 2021).

The definition of the circular economy is not uniform in the literature (Murray et al., 2017; Lakatos et al., 2021; Kirchherr et al., 2017) and its theoretical concept is quite unclear (Geissdoerfer, 2020). It is mainly associated with the principle of "closing the loops" – closing or circulating material flows within product and material systems. Within this economy, new business models are emerging that use and dispose of materials and resources in new ways (Dantas et al., 2021), models that lead to the minimization of resource depletion, waste, and

emissions (Geissdoerfer et al., 2020) and to the responsible and circular use of resources to maintain their value in the economy (Geisendorf & Pietrulla, 2018). As Morseletto (2020) points out, the concept is most often referred to as a restorative and regenerative economy, but restoration is a more appropriate term for its underlying principle and its broad application. According to the results of an analysis of 114 definitions, published by Kirchherr et al. (2017), the term circular economy is primarily defined as a combination of reduction, reuse and recycle activities, but do not always emphasize the requirement for "a systemic shift" and contain only few explicit links between the circular economy and sustainable development. Murray et al. (2017) points out that the circular economy is most often associated with the achievement of economic and environmental goals, but minimal attention is paid to social goals. Therefore, he extends the definition to include these goals, like Ghisellini et al. (2018). Moreover, in pursuit of the Sustainable Development Goals (SDGs), the circular economy can be advantageously combined with new Industry 4.0 technologies, which bring new opportunities for closing the loop; there is growing interest in the practical applications of this combination (Dantas et al., 2021; Preut et al., 2021; Bakes, et al., 2022).

Various approaches have been developed to achieve the goals of the circular economy, most commonly referred to as R-strategies or R-frameworks. Among the most common are the 3Rs – Reduce, Re-use, Recycle, which have been gradually complemented by other strategies. At the highest level of circularity stands Refuse, followed by Rethink, Reduce, Re-use, Repair, Refurbish, Remanufacture, Repurpose, Recycle and Recover (Potting et al., 2017). Higher circularity strategies do not necessarily involve reverse flows of products, components, or recycled materials, but may involve outright rejection or better use of the product or smarter manufacturing; medium strategies focus on extending the life cycle of the product including its parts; and the lowest level circularity strategies represent the beneficial use of materials that are recovered through recycling and incineration (Potting et al., 2017). Higher circularity strategies include, for example, engaging products in the sharing economy in which the product is used more intensively during its lifetime (Jelinkova et al., 2021; Tetrevova et al., 2021). The highest attention is usually paid to the recycling strategy (Potting et al., 2017), but implemented activities could be often categorized within more than one strategy.

Transition to a circular economy requires innovation, new business models or socio-institutional changes (Williams, 2021). Potting et al. (2017) distinguish three types of transitions to the circular economy: 1. transitions through radically new technology, where social-institutional change gives the new technology a place in society; 2. transitions through social-institutional change, with a secondary role for technological innovation; 3. transitions through social-institutional change, with technology facilitating these transitions. The circular activities could be implemented in the form of projects using project management methods and tools (Kostalova & Tetrevova, 2014; 2018). According to de Jesus and Mendonça (2018), circular economy practices are mainly influenced by social, regulatory or institutional factors; the "hard" barriers are related to the availability of technical solutions and financial factors, the transition to the circular economy requires both technological innovation and institutional changes in markets, public policies and social practices.

The circular economy is an economic system that includes business models of production, distribution and consumption processes, and could be implemented both at the micro level (products, consumers, companies), the meso level (clusters, eco-industrial parks) and the macro level (cities, regions, countries) (Kirchherr at al., 2017). At the city level, its importance is given by the fact that more than half of the world's human population lives in cities, they account for two-thirds of global energy consumption, more than 70% of greenhouse gas emissions etc. (The World Bank, 2023). At the same time, municipalities are expected to be responsible for coordinating and communicating national strategies to local communities and businesses (Dagiliene et al., 2021; Tetrevova & Jelinkova, 2019). The importance of ensuring practices that are in line with sustainable development at the municipal level is also reflected in the fact that their duties often correspond to social responsibility activities (Tetrevova & Jelinkova, 2019). That is also why cities worldwide implement strategies within their transition towards a circular economy (Henrysson et al., 2022). Prendeville et al. (2018, p. 187) sees the concept of circular city in a broad context, as an element of development to ensure its future-proofness and define it as "*a city that practices circular economy principles to close resource loops, in partnership with the city's stakeholders (citizens, community, business and knowledge stakeholders), to realize its vision of a future-proof city*". The benefits from implementations of circular activities can be perceived in all three pillars of sustainable development: environment (reducing resource consumption; restoring urban ecosystem services; reducing greenhouse gas emissions; adaptability to climate change; increasing environmental awareness), economic (reduced supply and production costs to producers; creation of economic value; economy diversification, job creation) and society (health and community benefits) (Williams, 2021).

However, research on the implementation of circular economy activities by local governments has so far been carried out in a rather "fragmented manner" (Dagiliene et al., 2021). Urban policy makers do not often have a clear idea of the purpose and form of a circular city, which form strategic ambitions up to a dedicated smart city concept (Lakatos et al., 2021). Challenges, for example, in municipal waste management, distribution of human resources, networking has been identified, municipalities also commonly face ambivalent goals (Dagiliene et al., 2021). So, it is obvious that a comprehensive analysis is needed on how to implement circular economy in cities and how to become fully sustainable (Lakatos et al., 2021).

This article presents research results in the field of implementing circular activities in cities. The subject of interest was not the largest world or European cities, whose circular practices have already been given attention in some research (Williams, 2021), but the circular activities of cities in Norway, a country that has long been ranked among countries with a positive attitude towards sustainability and environment, were analyzed. The goal was to analyze the circular activities, the implementation of which these cities inform the general public, to describe what activities the cities implement, to find out the level of their communication, to find out what circularity strategies are used, at what level of circularity and to identify examples of good practice interesting for use in other cities.

2. Methodology

The literature review became the basis of subsequent primary research that was carried out as part of the project "Towards Regenerative and Sustainable Development and Society"

supported by the Fund for Bilateral Relations within the framework of the EEA and Norway Grants 2014-2021. A partial goal of this project was to analyze circular activities in the largest Norwegian cities and also to find inspiration for cities in other countries and to fill some gaps that literature on circular economy is struggling with. Norway can be considered an important source of inventions, as it is traditionally very proactive in the field of environment and sets ambitious goals. Already in 2020, it announced a strengthened climate target until 2030 as part of the Paris Agreement, and subsequently the Norwegian government strengthened the national climate targets for 2050 as well - a reduction of emissions by 90 to 95 % from the level of emissions in 1990 (Redjeringen.no, 2022). Of course, these intentions are also reflected in the support of the circular economy, which was part of the Granavolden government platform in previous years with the aim of making Norway a pioneer of a green, circular economy that makes better use of resources (Sutcliffe & Alvarado, 2021). Currently, these trends are reflected in the national strategy for circular economy in Norway (Circular regions, 2022).

In order to be able to assess the involvement of cities in the framework of the development of circular economy strategies, primary research was conducted to analyze the circular activities published by selected Norwegian cities on their official websites. The cities' websites were chosen as a suitable source of data given that they still play the most important role among the digital tools used by public institutions to provide information (Urs & Spoaller, 2022). This is because they are considered part of the "public face" of the institution (Karani et al., 2021), serve as the main tool for "branding" the city (Manoharan & Wu, 2022) and, last but not least, they also represent the main channel through which cities communicate with citizens and offer their digital public services (Urs & Spoaller, 2022). Based on these facts, the use of a website seemed optimal to meet the research objective of identifying examples of good practice of Norwegian municipalities in the area of their circular activities. The research was carried out in 2021 and included the 25 largest Norwegian cities based on their population according to Statistics Norway on 1 January 2021. An overview of these cities is presented in Table 1.

Table 1. Characteristics of the research sample of Norwegian cities (processed according to Statistisk sentralbyrå, 2023)

City	Population as of 1.1.2021	City	Population as of 1.1.2021
Bergen	285,601	Nordre Follo	60,034
Trondheim	207,595	Sarpsborg	57,372
Stavanger	144,147	Tønsberg	57,026
Bærum	128,233	Skien	55,144
Kristiansand	112,588	Bodø	52,560
Drammen	101,859	Moss	49,668
Asker	94,915	Larvik	47,499
Lillestrøm	86,953	Indre Østfold	45,201
Fredrikstad	83,193	Arendal	45,065
Sandnes	80,450	Lørenskog	42,740
Tromsø	77,095	Karmøy	42,345
Ålesund	66,670	Ullensaker	40,459
Sandefjord	64,345		
Total			*1,777,015*

The sample of Norwegian cities was selected to include more than 25% of Norwegian settlements with city status, which are home to 33% of the total Norwegian population. These largest Norwegian cities could be expected to implement and communicate a large number of the circular activities that are the subject of our investigation. The capital city of Norway, Oslo, which, unlike all other studied municipalities, is both a county and a municipality, was excluded from the analysis due to this specificity.

To fulfill the goal of our research, the following research questions were formulated:

1. Do larger Norwegian cities communicate more circulation activities on their websites than smaller cities? Does the level of communication of these activities depend on the size of the municipality?
2. Do all larger Norwegian cities inform about their circular activities at least to a minimal extent? Does each of the monitored larger Norwegian cities mention at least one interesting circular economy activity on their website?
3. Does the structure of communicated recycling activities of municipalities correspond to the structure of circular strategies identified in other researches (Potting et al., 2017) i.e., most activities can be identified in the area of Recycle strategy?
4. Is it possible to identify some interesting practices of circular activities published by the monitored cities, which are specific to the cities and are an example of good practice for other cities in the phase of transition to a circular city?

Finding answers to the research questions specified above required an in-depth content qualitative analysis of the official websites of selected Norwegian cities. As part of this analysis, an online search was applied using web browsers installed directly on the analyzed websites. Keywords such as "social responsibility", "environmental project", "circular activity" etc. were used for the search. From the information found, only those activities or projects presented on the website that fall under circular economy procedures were subsequently subjected to a thorough analysis. In order to determine the structure and assess the level of circularity, these activities were further classified into one of the strategies R0 to R9, listed by Potting et al. (2017). The results were sorted, organized and statistically and analytically evaluated.

3. Results

The investigation showed that all Norwegian cities surveyed have their own official websites. It is noteworthy that only 8 of the 25 Norwegian municipalities surveyed, i.e. only 32 %, have a website in English and 68 % of them have a website in Norwegian only, and exceptionally some of the websites link to the Google translation option.

The qualitative analysis of the websites has enabled an overview of the circular activities presented by the major Norwegian cities. The following Table 2 shows the total number of identified circular activities presented on the websites of each analyzed Norwegian city.

Table 2. Numbers of circular activities on the websites of the monitored cities

City	No. of identified activities	City	No. of identified activities
Bergen	5	Nordre Follo	5
Trondheim	4	Sarpsborg	2
Stavanger	12	Tønsberg	1
Bærum	15	Skien	1
Kristiansand	3	Bodø	6
Drammen	2	Moss	2
Asker	20	Larvik	2
Lillestrøm	6	Indre Østfold	2
Fredrikstad	5	Arendal	4
Sandnes	4	Lørenskog	1
Tromsø	2	Karmøy	2
Ålesund	3	Ullensaker	5
Sandefjord	6		

Table 3. Activities of Norwegian cities in the field of smarter product use and manufacture

Circular strategy	Description of city activity	Engaged cities
R0 – Refuse	Grant support for the purchase of cloth diapers to avoid the consumption of non-organic disposable diapers	Asker, Sandnes, Stavanger
	Efforts to shift all personal transport around the city to public transport, walking and cycling	Ålesund, Kristiansand, Larvik, Lørenskog, Moss, Nordre Follo
R1 – Rethink	Creating and supporting coworking centers to foster innovation in sustainable solutions	Asker, Kristiansand, Larvik, Lillestrøm
	Creating smart multifunctional transport hubs and terminals to reduce the number of cars in the city	Asker, Bærum, Bergen, Drammen, Stavanger, Tromso
	Promoting urban transport through shared electric vehicles	Bodø, Moss
	Use of car sharing by City Hall employees	Ålesund, Bodø, Bergen, Trondheim
	Multifunctional infor. system for intelligent outdoor lighting	Bærum
	Multifunctional smart water meters for better water manag.	Bodø
	Operating a dishware rental service to reduce the use of disposable products	Stavanger
R2 - Reduce	Participation in research projects of mutually cooperating municipalities (often international) aiming at the transition to a low-carbon society, contributing to circular practices and efficient use of energy (7 specific projects identified)	Arendal, Asker, Bærum, Bergen, Bodø, Drammen, Kristiansand, Lillestrøm, Stavanger, Trondheim
	Achieving energy savings by providing free and non-binding energy advice to the citizens of the city	Asker, Bærum, Fredrikstad, Lillestrøm Sandefjord, Skien
	Energy savings thanks to intelligent outdoor lighting system	Tønsberg, Sandefjord
	Demand for circular solutions in public procurement	Arendal, Sandefjord, Sandnes
	Reducing fossil fuel consumption by promoting the electrification of transport	Alesund, Arendal, Bærum, Karmøv, Lillestrøm, Sandefjord, Sandnes, Stavanger, Tromsø
	Promoting the use of renewable energy sources - e.g. solar panels, biofuels and hydrogen.	Bærum, Lillestrøm, Sandefjord
	Promotion of low-energy projects and construction of passive houses	Bærum
	Interest in reducing emissions, fossil fuel consumption and packaging waste on construction sites	Bærum, Indre Østfold, Lillestrøm, Sandefjord, Sandnes
	Efforts to increase citizen engagement in reducing food waste	Asker, Bærum, Bergen, Fredrikstad, Sarpsborg, Stavanger, Trondhaim
	Encouraging home and school production of fruit and vegetables to reduce transport and waste	Asker, Indre Østfold

In Tables 3, 4 and 5 the activities are broken down according to the different categories of circular strategies based on the list of strategies published by Potting et al. (2017). Although some activities naturally cross several R-strategy categories, the activity has always been included in the category that is primary to the activity. Table 3 captures the activities aimed at a smarter product use and manufacture. Table 4 is oriented towards presenting activities aimed at extending the lifespan of a product or its parts, and Table 5 describes activities in the field of useful application of materials.

Table 4. Activities of Norwegian cities in the field of extending the lifespan of product or its parts

Circular strategy	Description of city activity	Engaged cities
R3 - Reuse	Information on product reuse on the City Hall website	Stavanger, Ullensaker
	A project seeking to create a market system that facilitates the local recovery of the value of unused building materials	Asker, Bærum
	Setting up shopping centers for the re-use of things	Asker, Bærum
	Organization of the Sunday "garage sale"	Stavanger
	Establishment of collection points and recycling stations allowing the handing over and often the purchase of used items	Asker, Ullensaker, Nordre Follo
	Shared fridge operation	Asker
R4 - Repair	City Hall's website offers tips and links to various initiatives that teach residents how to repair damaged products	Stavanger, Ullensaker
	Repairs can be carried out in established buyback centers	Asker, Bærum
	Organization of creative reuse courses, it is possible to learn how to repair things in a sustainable and environmentally friendly way	Asker, Bærum
	Support for Repair Cafés or repair evenings and groups	Asker, Stavanger, Ullensaker
	Repair of brought items at recycling stations	Asker, Nordre Follo
R5 – Refurbish	Within the creative reuse courses, participants learn how to upgrade old items in a sustainable and environ. friendly way, etc.	Asker
R6 – Remanufacture	Organizing cooking courses from leftovers	Asker, Bærum, Bergen, Fredrikstad, Sarpsborg, Stavanger, Trondhaim
	City Hall's website offers citizens tips and links on how to use leftover products to reduce waste	Stavanger, Ullensaker
R7 - Repurpose	Responsible approach to unused building materials, their further use in other constructions and purposes - initiative of the town hall	Asker, Bærum
	Use of energy and by-products from wastewater treatment plants	Bodø, Sarpsborg

Table 5. Activities of Norwegian cities in the field of useful application of materials

Circular strategy	Description of city activity	Engaged cities
R8 - Recycle	The creation of a sustainable industrial park, where one company's waste could become a commodity in another one's production	Arendal
	Building modern recycling stations and treatment plants	Karmøy
	A responsible and sustainable approach to waste recycling	Asker, Fredrikstad, Norde Follo
R9 - Recover	Use of energy from wastewater treatment plants – heat generation	Bodø
	The residual waste that remains after sorting is sent for incineration with energy recovery	Asker, Fredrikstad, Norde Follo

The numbers of individual activities and the numbers of cities involved in these activities identified within the categories of circular R-strategies are demonstrated in Table 6.

Table 6. The number of identified activities and the number of cities involved in a specific circular strategy

Circular strategy	Total number of identified activities	Number of cities involved
R0 - Refuse	2	9
R1 - Rethink	7	13
R2 - Reduce	10	20
R3 - Re-use	6	5
R4 - Repair	5	5
R5 - Refurbish	1	1
R6 - Remanufacture	2	8
R7 - Repurpose	2	4
R8 - Recycle	3	5
R9 - Recover	2	4

Table 6 clearly shows that the monitored Norwegian cities communicate to the greatest extent circular activities from the area of the R2 - Reduce strategy, the aim of which is to reduce the consumption of natural resources, materials and energy through their more efficient and sustainable use. From the point of view of the analyzed municipalities, the R1 - Rethink strategy based on more intensive use of resources is also popular, followed by activities using the R3 - Re-use and R4 - Repair strategies.

Discussion and Conclusions

A detailed analysis of the official websites of selected large Norwegian cities allowed us to answer the set research questions:

Question 1 The research results indicate that the frequency of communicated circular activities on websites does not depend on the size of the municipality according to the number of its inhabitants, but apparently on other factors. The fact that the size of the city does not affect the level of communication may be surprising because, for example, in Europe, large cities such as Amsterdam, Paris, London, Stockholm were the pioneers in the introduction of circular systems (Williams, 2021), and the same is true in other regions. Unfortunately, the scope of our research did not allow us to analyze more deeply the reasons why the Norwegian cities of Asker, Bærum and Stavanger show a higher level of communication of circular activities than other larger Norwegian cities. However, this question could be a suitable topic for future research.

Question 2. It is clear that the monitored Norwegian cities are interested in circular activities, in the research sample, no city was identified that did not mention any circular activity. Only 3 municipalities communicated only one circular activity on their website, which is only 12% of the monitored cities. On the contrary, 10 analyzed municipalities communicate 5 or more circular activities on their website, which is 40% of the monitored cities.

Question 3. An interesting finding within the research was the fact that the structure of communicated circular activities of municipalities does not correspond to the structure of

these activities identified in the literature. While in the literature most activities can usually be identified in the area of strategies R8 - Recycle (Potting et al., 2017), in the cities analyzed, activities falling under the category of strategy R2 - Reduce were the most often mentioned. It is apparently caused by different approaches to solving circular problems from the city's point of view. Businesses more often solve operational and technical problems associated with the production of waste and its recycling or reuse, which corresponds to a number of activities within the Recycle strategy. Rather, cities strive to educate, engage and motivate citizens and businesses to save and use resources more efficiently, which is reflected in the R2 - Reduce strategies.

Question 4. All the circular activities identified on the websites of selected Norwegian cities presented in Tables 3, 4 and 5 can be an interesting example for other cities that are in the phase of preparation or transition to a circular city. The research results revealed the following interesting circular city transition activities:

- Participation in international research projects focused on the development of the circular economy and the transfer of experience with the implementation of various circular activities.
- Orientation to circular principles in the framework of transport in cities – e.g. sharing and electrification of means of transport, creation of multifunctional transport hubs and terminals, etc.
- Involvement of the principles of Industry 4.0 within circular activities in the city – e.g. multifunctional information system within intelligent outdoor lighting, intelligent water meters, etc.
- Circular activity in construction – support of low-energy projects, construction of passive houses, circular approach to building materials, materials and packaging.
- Establishing repurchase centers and recycling stations.
- Web information support of various circular activities directly on the official website of the town hall, where cities offer citizens tips and links to various ways of reusing products, possibilities of their repair, consumption of leftovers, etc.

The identification of the most important circular activities of the monitored cities is partly complicated by the fact that the research was conducted only in Norway. An interesting topic for further research would therefore be to identify the circular activities presented by similar municipalities in other countries as well, e.g. in the Czech Republic, and compare them with each other. Possibilities for follow-up research also result from other limitations of our investigation. The presented research was focused only on the activities that cities communicate, which does not always correspond exactly to the number of activities that might be implemented at the same time. Activities that were intended to be implemented could be published but it is not always clear to what extent they were implemented. On the other hand, cities can implement more activities than they list on their websites. Finding out this fact would certainly require a deeper qualitative analysis based on personal interviewing of the responsible employees of the analyzed cities. The authors also did not address the

identification of factors that influenced the implementation of circular activities in the analyzed cities, which would certainly be interesting for determining the driving forces and limits of the implementation of circular activities within municipalities.

Despite the obvious limitations of our research, we believe that the investigation provided interesting results and topics that can be used in the implementation of circular activities in other cities.

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Assessing the Role of the Digital Economy on Carbon Emissions: New Evidence Based on the Spatial Durbin Model

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Abstract: With the advancement of industrialization, the problem of global warming is becoming increasingly serious. In order to reduce greenhouse gas emissions, China has proposed the goals of "Peak carbon dioxide emissions" and "Carbon neutrality". Meanwhile, under the background of computer technology, digital economy gradually takes shape, and it affects all aspects of society. In particular, it provides impetus for economic growth. While promoting economic innovation and development, whether the digital economy can reduce carbon emissions in China is worthy of in-depth research. However, it is rarely studied in the existing literature. In this paper, 261 samples were selected from the municipal level, covering the period from 2011 to 2017. Considering the possible influence of space, we construct a spatial Durbin model to explore the relationship between the digital economy and carbon emissions. We found that the digital economy can mitigate carbon emissions both locally and in neighboring areas. In addition, the digital economy has a bearing on carbon emissions which varies in different regions. Research conclusions provide useful policy implications for better promoting the development of the digital economy and helping to achieve the "dual carbon" target.

Keywords: digital economy; carbon emissions; spatial Durbin model; spatial spillover effects

JEL Classification: B23; C23

1. Introduction

Since the Industrial Revolution, the increase in productivity has led to an increasing consumption of natural resources, and various large-scale production activities have also led to a large number of greenhouse gas emissions, causing serious global warming problems. In this context, countries have introduced policies to reduce greenhouse gas emissions. In order to solve the problem of global warming, China has also proposed "peak carbon dioxide emissions" and "carbon neutrality" goals.

The digital economy is a new economic structure born from the quick advancement of computer technology. However, there is no authoritative statement on the connotation of digital economy at present, scholars understand the digital economy from different angles. The most recognized definition of digital economy is the initiative proposed by the Hangzhou G20 Summit 2016: the digital economy contains a series of economic activities, its production factor is digital knowledge and information, the carrier is modern information network, and the core

driving force is the use of information and communication technology to improve efficiency and optimize economic structure.

After the advent of the digital economy, many scholars (Deng & Zhang, 2022; Li & Zhou, 2021; Guo et al., 2022; Wu et al., 2021) have studied the impact of the digital economy on environmental quality in detail, and the results of the research have consistently shown that the development of the digital economy helps improve environmental quality. Since the development of the digital economy can effectively improve environmental quality, the digital economy can exert the same effect for carbon emissions? In addition, when studying the relationship between things, it is one-sided to consider only the causal relationship between two variables, and the spatial correlation between individuals should not be ignored. With the development and improvement of econometric models, spatial metrology has been widely used in the study of economic problems. Among them, the spatial Durbin model introduces the spatial lag term of explanatory variables on the basis of the spatial lag model, and can be transformed into other models when some constraints are made on the parameters.

Based on this question, this article conducts research. We found that the development of the digital economy can relieve urban CO2 emissions when spatial spillover effects were considered. This paper provides new perspectives and ideas for achieving green and low carbon development and improving global warming, and the role of the digital economy should be fully exerted in future carbon emission reduction work.

2. Theoretical Part

2.1. Literature Review

Studies already conducted on how the digital economy affects carbon emissions can be roughly divided into three groups. According to certain research, the growth of the digital economy results in higher carbon emissions. Some scholars believe that the rapid development of the ICT industry leads to excessive consumption of electricity, which in turn drives an increase in carbon emissions (Salahuddin & Alam, 2015). Utilizing data from the top 10 countries in the world in 2019, some studies have concluded that digitalization does not support the growth of a green and energy-efficient economy, indicating that the pace of digital economy growth must be constrained in order to achieve the global sustainable development goals (Shvakov & Petrova, 2019).

According to some studies, the growth of the digital economy will contribute to the decrease of carbon emissions. Some studies have shown that digital technology can increase labor productivity, facilitate the effective allocation of resources, and support the transition of high-carbon industries to low-carbon ones (Wu & Ren, 2021). Wu Yin proposed at the Bi-Carbon Strategy and Energy Digitalization Forum held in October 2021 that digital technology can interconnect various energy systems based on electricity, optimize the energy supply system, and reduce direct carbon emissions in the terminal sector, thereby reducing carbon dioxide emissions. The development of artificial intelligence, according to Jiang Yan's argument at the forum "Digital Technology Empowers Green and Low-Carbon Development of the Industry," can support the growth of clean energy, reduce carbon emissions

throughout the supply chain, and intelligently monitor inefficient production capacity. Shobande believes that in the long run, increased Internet penetration will significantly reduce carbon emissions (Shobande, 2021). Bhujabal believes that increasing investment in ICT infrastructure also has a significant effect on reducing carbon emissions (Bhujabal et al., 2021). The relationship between the digital economy and carbon emissions from the provincial level was studied using data from 2011 to 2018, and the findings indicated that the intensity of carbon emissions will decrease as the digital economy develops (Xie, 2022). When researching the influence of the energy structure on carbon emissions, Li Y included the digital economy as a moderating variable. The findings revealed that as the amount of digital economy growth increases, the energy structure's inhibitory effect on carbon emissions becomes stronger (Li et al., 2021). Xu used the spatial Durbin model for the first time to study the relationship between the two, and the results show that with the development of the digital economy, the carbon emissions of both local and neighboring places will decrease (Xu et al., 2022).

In addition, Li X. introduced the digital economy as a technological progress in the Solow growth model, performed fixed-effect regression based on global panel data from 190 countries. They discovered a nonlinear association between carbon dioxide emissions and the digital economy that is structured like an inverted U. At the beginning of digitalization, due to increased productivity, enterprises produce more goods, thereby releasing more carbon dioxide; When the level of digitalization is high, the amount of carbon dioxide processed is greater than the emission of carbon dioxide. Currently, businesses' production levels tend to be stable, and technological advancement helps the economy develop sustainably (Li et al.,2021).

In conclusion, numerous academics have assessed the state of the digital economy, and despite the lack of a standardized and cohesive indicator system, it is clear that the indicator dimension is constantly developing. However, few publications at this point make the growth of the digital economy and carbon emissions their primary study topics, and there are very few discussions on the relationship between the two, and they are basically qualitative, lacking the support of empirical models. Additionally, both quantitative research and practical testing rarely take into account the spatial association between the digital economy and carbon emissions, and simple panel regression estimation coefficients may not accurately reflect the magnitude of the effect between variables, so this article uses the spatial Durbin model for research.

2.2. Theoretical Analysis and Research Hypotheses

Companies can engage in a variety of digital economic activities without equity linkage since the digital economy exhibits the traits of a "participant economy", which also leads to its important role in reducing carbon emissions from the entire business activity (Li Y. et al., 2021). By enabling consumers and even the upstream and downstream entities of the entire supply chain to participate, the digital platform of the enterprise reduces the carbon emissions of the enterprise, thereby achieving carbon emission reduction in the entire

business process. Online shopping, working from home, and online education also significantly reduce people's travel.

Additionally, as the size of the digital economy continues to grow, the digital economy has replaced many traditional economies, and the optimization of the power system and energy structure of traditional industries through digital technology will help reduce the carbon emissions of the entire society. The transition from manufacturing to services will significantly reduce society's reliance on fossil fuels, which is another essential step toward reducing carbon emissions. The digital economy also plays a significant role in fostering this improvement in industrial structure. Overall, the digital economy can drive the achievement of the "dual carbon" target and promote the green development of society. Therefore, the first hypothesis of this paper is proposed: carbon emissions are being hampered by the growth of the digital economy.

In general, economic activities between neighboring regions will affect each other, and digital technologies and emission reduction technologies are easier to circulate. In addition, the digital economy can break through traditional regional boundaries by making use of the spread of the Internet. The cost of information transmission and processing has significantly decreased with the rapid growth of digital technologies like the Internet, big data, and cloud computing, particularly under the effect of Moore's law, enhancing the mobility of data. The properties of the digital economy allow for the reduction of local carbon emissions while hindering the growth of nearby regions, which is sometimes referred to as a positive externality of the digital economy.

Therefore, this study creates a spatial econometric model for research, taking into account the fact that the spatial spillover effect of the digital economy cannot be ignored, while examining the influence of the digital economy on carbon emissions. So, the second hypothesis is put forward: the digital economy can inhibit the carbon emissions of adjacent areas through spatial spillover.

3. Methodology

3.1. Model Specification

In order to measure the strength of the relationship between the units in the space, the following matrix is constructed, where w_{ij} indicates the influence degree of individual i on individual j in the space:

$$W = \begin{bmatrix} 0 & w_{12} & \cdots & w_{1n} \\ w_{21} & 0 & \cdots & w_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ w_{n1} & w_{n2} & \cdots & 0 \end{bmatrix} \tag{1}$$

As there are many types of spatial weight matrix, this paper refers to the relevant research, considering the simplicity of matrix construction, and selects the following two most commonly used for research.

The rules for constructing the adjacency weight matrix are as follows:

$$w_{ij} = \begin{cases} 1, & \text{Spatial units i and j have a common boundary} \\ 0, & \text{Spatial elements i and j have no common boundary, or i = j} \end{cases}$$

The geographical distance weight matrix assumes that the spatial effect is negatively correlated with the unit distance, and the form is as follows:

$w_{ij} = \frac{1}{d_{ij}}$ (d_{ij} represents the geographic center distance of the spatial units i and j)

Spatial autocorrelation test is the premise of spatial econometric analysis. According to the first law of Geography: Everything is related and the closer the distance, the closer the relationship will be. When examining the relationship between the two variables, we should consider the interaction between adjacent areas, that is, spatial effect. At present, the commonly used indicators to investigate the spatial autocorrelation of data are Moran index *I* and Geary index *C*. In this paper, Moran index is used to analyze the global spatial autocorrelation.

The formula for the global Moran index is as follows:

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(y_i-\bar{y})(y_j-\bar{y})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}}, \quad (2)$$

$$S^2 = \sum_{i=1}^{n}(y_i-\bar{y})^2/n,\ \bar{y} = \sum_{i=1}^{n} y_i/n,\ w_{ij} \quad (3)$$

is an element in the spatial weight matrix, as described above, y_i represents the value of the ith sample on the variable y, y_j represents the value of the *j*th sample on the variable *y*, and *n* represents the sample size.

The global Moran Index *I* has a range of $-1 \leq I \leq 1$, which describes the overall distribution of variables and determines whether they will agglomerate in space. When *I* is less than 0, it indicates that there is a spatial negative correlation between the variable Y, implying that there is a large difference between adjacent elements; When *I* is more than 0, it indicates a positive spatial correlation, implying that the values of adjacent cells on variable Y are very close, and the high value (or low value) regions are clustered together; When *I* is equal to 0, the variable Y is randomly distributed.

When estimating the effect of the development of the digital economy on carbon emission, the regression coefficient may be inaccurate if the conventional panel model is used directly due to the clear spatial correlation between the level of development of the digital economy and the level of carbon emission in cities. Therefore, it is necessary to establish a spatial econometric model.

In order to select the appropriate model, this paper has carried out a series of tests including LM test, Hausman test, LR test, and Wald test (Because of limited space, test results are omitted from the article). Finally, the SDM model was selected for empirical research, and the model settings were as follows.

$$\ln CO2_{it} = \rho \sum_{j=1,j\neq i}^{n} W_{ij} \ln CO2_{it} + \beta_1 \ln X_{it} + \gamma_1 \sum_{j=1}^{n} W_{ij} \ln X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

The difference between the spatial Durbin model and the ordinary panel model is that the spatial lag term of the explanatory variable is introduced as the explanatory variable, that is, the first term at the right end of the above formula. $\ln CO2_{it}$ represents local CO2 emissions, $\sum_{j=1,j\neq i}^{n} W_{ij} \ln CO2_{it}$ indicates the CO2 emissions of neighboring

areas, and the coefficient ρ reflects the impact of CO2 emissions from neighboring areas on local CO2 emissions, also known as spatial spillover. In addition, the spatial Durbin model also introduces the spatial lag term of the explanatory variable (which is an important difference between the spatial Durbin model and the spatial lag model), which is the third at the right end of the above equation, which is to measure the impact of the development of the digital economy and other control variables on local CO2 emissions in neighboring areas.

$CO2_{it}$ represents the city's level of carbon emissions; X_{it} denotes explanatory variables, including core explanatory variables and control variables; ρ is the spatial lag regression coefficient of the dependent variable, which depicts the relationship between regional carbon emissions and those of nearby locations; β_1 is the regression coefficient for the explanatory variables; γ_1 is the spatial lag regression coefficient of the explanatory variable, which indicates the effect of the development of the local digital economy on the carbon emissions of neighboring areas; μ_i indicates regional effects; λ_t means the time effect; ε_{it} is a random perturbation term.

3.2. Variable Selection

In this paper, the carbon dioxide emission (million tons) is selected as a dependent variable and is expressed by lnco2. The measurement method is the apparent emission accounting method. Urban carbon emissions are calculated by adding the carbon emissions of the counties under their jurisdiction.

Table 1. Evaluation index system of digital economy development

Primary indicator	Secondary indicator	Tertiary indicator	Indicator attribute
Digital economy development index	Internet penetration rate	Number of Internet broadband access users per 100 people	+
	Number of internet-related employees	Proportion of information transmission computer service and software industry in employees of urban units	+
	Internet-related outputs	Per capita telecom business income (10,000 RMB)	+
	Number of mobile Internet users	Number of mobile phone subscribers per 100 people	+
	Inclusive development of digital finance	China Digital Financial Inclusion Index	+

The Digital Economy Development Index is the explanatory variable. Five indicators were chosen in accordance with the index system created by Zhao Tao to assess the state of the urban digital economy (Zhao et al., 2020), and the entropy weight method was used to synthesize the digital economy development index (DIGE). Table 1 displays the indexing methodology for the digital economy development index.

In this paper, six control variables are selected with reference to the relevant literature on the factors that influence carbon emissions according to Table 2.

Table 2. Description of the control variables

	Primary indicator	Secondary indicator
Economic level	Level of economic development	Per capita GDP（gdpp）
Demographic level	Population size	Resident population (popu)
Technical level	Technological innovation	Patent authorization (pat)
Others	Industrial structure	Industrial structure supererogation (indu)
	Urbanization level	Urbanization rate (city)
	Investment in fixed assets	Amount of investment in fixed assets (fai)

3.3. Data Sources

Data from 261 Chinese prefecture-level cities between the years of 2011 and 2017 are used in this study, and some missing data are filled up using linear interpolation. Additionally, every statistic in the empirical portion is logarithmic, with the exception of the digital economy development index. The Peking University's Digital Finance Research Center provided the digital inclusive finance index, and the carbon emission data is derived from the county-level carbon dioxide emissions measured by Chen et al. (2020). The total carbon emissions of the counties under their authority are added to determine urban carbon emissions. The data of other indicators come from the urban statistical yearbook, wind database, EPS database, urban statistical bureaus, and Statistical Bulletins.

4. Results

4.1. Spatial Autocorrelation Test

Table 3. Results of the Global Moran Index

Year	Moran Index			
	Digital economy Development index		Carbon dioxide emissions	
	The adjacency weight matrix	The geographic distance weights matrix	The adjacency weight matrix	The geographic distance weights matrix
2011	0.278***	0.077***	0.286***	0.080***
2012	0.252***	0.069***	0.284***	0.079***
2013	0.210***	0.057***	0.274***	0.075***
2014	0.206***	0.052***	0.270***	0.074***
2015	0.194***	0.050***	0.284***	0.079***
2016	0.186***	0.048***	0.282***	0.079***
2017	0.197***	0.051***	0.263***	0.072***

Note: ***, ** and * indicate a level of significance of 1%, 5%, and 10%, and the following table is the same.

Before estimating the spatial econometric model, calculate the Moran index to test whether there is spatial correlation. Table 3 shows that under the two spatial weight matrices, the Moran index values (I) of the digital economy development index and carbon dioxide emissions from 2011 to 2017 are significantly positive. This demonstrates the relationship between urban carbon emissions and the development of their digital economies as a spatial agglomeration phenomenon in China. It implies that the level of local carbon emissions and

the development of the local digital economy may have an impact on areas nearby, and it is initially shown that there is a spatial spillover effect.

4.2. Basic Regression

Table 4 demonstrates that the impact of the digital economy development index on CO2 emissions under both spatial weighting matrices is negative, at least with a significance level of at least 5% regardless of whether control variables are added, and the coefficient difference is small, indicating that the level of carbon emissions in cities can be significantly reduced by the development of the digital economy. Taking the adjacency weight matrix as an example, with the addition of control variables (model 2), there will be a 0.117% decrease in the city's carbon dioxide emissions for every unit increase in the digital economic development index. In addition, urban carbon emissions' spatial lag coefficient (rho) is noticeably positive, indicating that in China, there is a large spatial spillover impact on urban carbon emissions, and local carbon emissions have a positive impact on neighboring areas, which is confirmed by the Moran index calculated previously. The spatial lag coefficient of the digital economy development index is significantly negative, demonstrating how the digital economy has had a positive knock-on impact and decreased carbon emissions in nearby places. In this part, only the control variables with significant spatial lag coefficients are retained, and it can be found that under the two spatial weight matrices, the fixed asset investment (lnfai) of neighboring areas has a significant inhibitory effect on local carbon emissions (with coefficients of -0.021 and -0.166). Technological innovation (lnpat) in neighboring areas exacerbates local carbon emissions (with coefficients of 0.029 and 0.154).

Table 4. Results of basic regression

Explanatory variable	The adjacency weight matrix				The geographic distance weights matrix			
	Model 1		Model 2		Model 3		Model 4	
	x	W×x	x	W×x	x	W×x	x	W×x
dige	-0.150*** (0.049)	-0.287*** (0.089)	-0.117** (0.047)	-0.274*** (0.090)	-0.116** (0.050)	-1.275** (0.590)	-0.112** (0.051)	-3.070*** (0.673)
lnfai			0.030*** (0.006)	-0.021** (0.009)			0.037*** (0.006)	-0.166*** (0.042)
lnpat			0.001 (0.004)	0.029*** (0.006)			-0.001 (0.004)	0.154*** (0.027)
rho	0.505*** (0.023)		0.485*** (0.023)		2.440*** (0.047)		0.884*** (0.042)	
control variables	NO		YES		NO		YES	
time fixed	YES		YES		YES		YES	
individual fixed	YES		YES		YES		YES	
years	7		7		7		7	
cities	261		261		261		261	
R^2	0.018		0.024		0.034		0.041	
LogL	3,454.894		3,548.497		3,431.615		3,464.070	

Note: ***, ** and * indicate the level of significance of 1%, 5%, and 10%. What is reported in brackets in the table is the robust standard error.

4.3. Effect Decomposition

Due to the spatial lag term's feedback effect, that is, the coefficient of spatial lag term (rho) of the explained variable is significantly not 0, the coefficient value of spatial Durbin model in the benchmark regression cannot accurately reflect the degree of real influence between variables (Nan et al., 2022). Referring to the partial differential method of the spatial regression model proposed by Lesage and Pace (2009, p. 513–551), the direct effect and indirect effect are separated from the total effect of the spatial Durbin model to reduce the error in the estimation of coefficients, as shown in Table 5.

The results show that the direct effect of digital economy development on urban carbon emissions is significantly negative, specifically, when the local digital economy development index increases by 1 unit, there will be a 0.163% decrease in the local economy's carbon emissions. The development of the local digital economy has a spillover impact on nearby areas, reducing their carbon emissions, as shown by the indirect effect, which is also notably negative.

Table 5. Results of effect decomposition

Explanatory variable	The adjacency weight matrix		
	Direct effect	Indirect effect	Total effect
dige	-0.163*** (0.052)	-0.594*** (0.157)	-0.757*** (0.185)
lngdpp	0.090*** (0.014)	-0.065* (0.035)	0.025 (0.037)
lnindu	0.246** (0.113)	-0.319 (0.301)	-0.073 (0.329)
lnpopu	0.117*** (0.028)	0.117 (0.100)	0.233** (0.115)
lncity	0.077*** (0.018)	-0.101** (0.048)	-0.024 (0.058)
lnfai	0.029*** (0.006)	-0.013 (0.013)	0.016 (0.014)
lnpat	0.006 (0.004)	0.053*** (0.010)	0.058*** (0.011)
time fixed	YES		
individual fixed	YES		
years	7		
cities	261		
R^2	0.018		
LogL	3,548.497		

Note: ***, ** and * indicate the level of significance of 1%, 5%, and 10%. What is reported in brackets in the table is the robust standard error.

4.4. Robustness Test

By gradually adding the control variables and substituting per capita CO2 emissions for the explanatory variables, we discovered that the key explanatory variables' and lagging terms' coefficient estimates are still significant, their signs have not changed, and their fluctuation range is not very high, so the model is basically robust. (Because of space limitations, table results are not displayed.)

4.5. Spatial Heterogeneity Analysis

Taking into account the spatial variability of the influence of the digital economy's development on urban carbon emissions, we divide all cities into three regions: the east, the centre, and the west for regression. Due to the spatial lag term's feedback effect, the regression outcomes are displayed in Table 6 along with the effect's ongoing decomposition.

In the eastern region, the development of the digital economy has a significant inhibitory effect on local and adjacent carbon emissions. It may be that the Internet and computer technology in the eastern region are quite mature, with a high degree of digitization, and the digital technology is deeply integrated with the real economy. Economic activities are more energy-saving and environmentally friendly. The developed digital technology also promotes the development of new energy. Therefore, the effect of the digital economy on reducing carbon emissions is stronger. In the central region, the development of the digital economy has no obvious effect in alleviating local carbon emissions, but it has reduced the carbon emissions of neighboring regions. The reason may be that the development of digital economy in the central region is later than that in the eastern region, the Internet and digitization level are not high, and the infrastructure is not sophisticated, so the effect of carbon emission reduction is not as obvious as that in the eastern region. In the western region, the development of the digital economy has no significant impact on local and adjacent carbon emissions. Our guess is that it is because the development of the digital economy in the western region is still in its primary stage, the degree of integration with the real economy is low, and the digital technology is not advanced enough, so it cannot play a significant role in reducing carbon emissions.

Table 6. Results of heterogeneity analysis

Digital economy development index	Eastern Region	Central Region	Western Region
Direct effect	-0.344*** (0.084)	-0.001 (0.083)	0.039 (0.097)
Indirect effect	-0.425* (0.252)	-1.285*** (0.264)	0.195 (0.204)
Total effect	-0.769** (0.297)	-1.285*** (0.312)	0.234 (0.261)
control variables	YES	YES	YES
time fixed	YES	YES	YES
individual fixed	YES	YES	YES
years	7	7	7
cities	101	100	60
R^2	0.039	0.003	0.190
LogL	1,418.265	1,521.658	812.362

Note: ***, ** and * indicate the level of significance of 1%, 5%, and 10%. What is reported in brackets in the table is the robust standard error.

5. Conclusions and Suggestions

5.1. Conclusions

We build a spatial Durbin model for empirical research to investigate the effects of the rise of the digital economy on carbon emissions. Three conclusions are reached as follows:

First, the expansion of the digital economy continues to have a sizable inhibitory effect on urban carbon emissions even after accounting for the spatial spillover effects of the digital economy and carbon emissions, which agrees with the findings of other academics' empirical studies employing regular panels. To ensure the reliability of the research results, robustness tests were carried out. After six control variables were introduced in turn and the explained variables were replaced by per capita carbon dioxide emissions, the findings demonstrated that the lag term and the main explanatory variable coefficient estimates were still significant, the symbols did not change, and the fluctuation range was small. The robustness test passed.

Second, considering the feedback effect of the spatial lag term, the partial differential method is used to decompose it. The results demonstrate that carbon emissions have been negatively impacted both directly and indirectly as the digital economy has grown. As a result, as the digital economy grows in a particular area, local carbon emissions are reduced as well as those in neighboring regions as a result of the spillover effect.

Third, all cities are divided into three regions: East, Centre and West for heterogeneity analysis. The results show that: In the eastern region, with the improvement of the level of development of the digital economy, the local and adjacent carbon emissions will be reduced. In the central region, the development of the digital economy will only reduce the carbon emissions of neighboring regions. In the western region, the development of the digital economy has no significant impact on carbon emissions.

5.2. Policy Suggestions

Based on the above research conclusions, this paper puts forward the following policy recommendations to better promote the development of the digital economy and help to achieve the "dual carbon" target:

First, the digital economy plays an important role in reducing carbon emissions which indicates we should accelerate the construction of the Internet and promote the deep integration of digital technology and economic activities. In addition, through scientific and technological innovation, we will break through a number of crucial technologies that support carbon emission reduction, vigorously develop new energy, and gradually increase the proportion of new energy.

Second, regional differences make the carbon reduction effect of digital economy diverse, which indicates it’s essential to carried out a dynamic and multiplex strategy. Especially for cities in the eastern region, continue to maintain the vitality of the digital economy and make it the technical support for regional carbon emission reduction. For the central region, we should make full use of the spillover effect of the neighboring digital economy and strengthen interregional cooperation, in order to help develop local digital technology and promote carbon emission reduction. For the western region, we should adjust the pace of digital economy development, strengthen policy guidance, and strongly support the development of digital industry, so that the digital economy can play an important role in the reduction of carbon emissions.

Conflict of interest: none

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Improving the Individual and Organizational Competencies in the Project Management Office

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Abstract: The paper presents the individual and organizational competencies necessary for the successful management of the Project management office (PMO). The aim of the paper is to provide a systematic literature review dealing with this topic, supported with a comparative analysis of competencies, and a recommended set of competencies crucial for PMO development. The contribution of this paper is the classification of individual and organizational competencies for the PMO, related to the PMO's purpose, whether it has an advisory, control or management function. Findings showed that the synergy of individual and organizational competencies for the PMO would contribute to better results and improvement of the PMO's operations. The recommendation for further development of this topic, which is based on the improvement of individual and organizational competencies for the PMO, is to conduct research in the form of a survey or questionnaire based on finding ways to improve these competencies among employees within an organization.

Keywords: project; project management; individual competencies; organizational competencies; PMO

JEL Classification: M12; M19

1. Introduction

Most of the authors in their literature state that the importance of research related to individual and organizational competencies for the PMO in the last few years stand out to a significant extent. Questions arise as to whether individual competencies, depending on which maturity level of the PMO they belong to, can be generalized and taken as a rule. This paper will consider whether organizational competencies depend on the strategic level at which the PMO unit was formed, but also whether the PMO unit is organized with an advisory function or it is of strategic importance for the organization. Competence improvement is an important milestone to enable employees and the organization to know how to react in certain situations. It is important to emphasize whether the PMO operates as a department, whether it has support functions, management or control functions. The purpose of the analysis of this topic and the comparison of individual and organizational competencies in PMO is to contribute to the strategic and operational development of PMO functions.

2. Literature Review

This section describes the various competencies based on the literature review in order to present a comparative review of the research in the field of individual and organizational competencies for the PMO. Analyzing the literature we can conclude that every author is putting effort to present the overall concept of competencies needed in PMO. Today, organizations face a competitive and globalized environment every day, as well as rapid changes in the market in which they operate (Silvius, 2020). For these reasons, it is recommended to form a special organizational department with an advisory, management, and/or control function to better understand the market's volatility. The concept of introducing a special office for project management has multiple responsibilities depending on which sphere of business the company is focused on (Pervaiz et al., 2003). Organizational restructuring of the existing organization tends to significantly contribute to the development of the organization. Since the PMO is formed in order to facilitate the coordination and management of projects, programmes and portfolios, several limitations should be noted. Sometimes the introduction of a PMO will not directly result in reductions in workload and easier coordination, but it can contribute to better control and implementation of corrective actions when goals are not aligned with the strategic plan (Julian, 2008; Salamah & Alnaji, 2014). In addition to this, in the initial stages of designing the organizational structure, there are requirements that a PMO must be introduced in order to properly implement projects in the organization. Sometimes this does not have to be taken as a necessary rule because sometimes it is enough to divide the work among different departments or to introduce some new rule or procedure in order to relieve the increased volume of work. If projects are of strategic importance, and if the project or program is too complex, it is suggested to adopt a new PMO Singh (Keil & Kasi, 2009). To conclude, the biggest challenge for the organization is to make a decision if they need PMO, and which maturity level is feasible and needed.

According to the research conducted by Salamah and Alnaji (2014), one of the main shortcomings that affects the performance of the PMO is the inadequate definition of the project management methodology. Implementation of an inadequately defined project management methodology and implementation of inadequate control often lead to PMO failure. According to this, reporting and insight into the status of projects become a challenge in every organization. Some of the challenges that arise in this research state the necessity and importance of having a PMO methodology for project management because the PMO is based on following the methodology in order to support project management to ensure the consistency of projects and inexperienced managers. This research has shown that one of the biggest challenges when implementing a PMO in an organization is the conflicts that arise when allocating resources to other projects within the same organization. According to Kaul and Joslin (2018), the key PMO performances are measuring work metrics and the performance of employees in the organization. The same authors have stated that a successful PMO creates discrete outcomes of its activities that are listed as:

- Completion of PMO setup,
- Project success,
- Increasing the services offered,
- Increasing the maturity of the PMO.

These results can be the results of internal activities carried out by the PMO or the results of a project, program or portfolio, still there are actually benefits that PMO provides to the organization.

Further, PMO stands out as an organizational structure to support and improves the practice of project management, in order to improve the efficiency and effectiveness of the organizational operations with the adopted methodologies and tools (Kaul & Joslin, 2018). In addition to this, Tsaturyan and Müller (2015) state in their paper that the implications for the introduction and networking of the PMO justify the development of related management dimensions in the organization. Also, the reviewed literature concerns the importance of individual competencies that support an effective PMO, since PMO requires different project management roles and often new employment. Whether it is information systems, legal or health systems, the competencies of project managers should always be monitored and in accordance with the react to changes in the environment by Tsaturyan and Müller (2015) and Obradović et al. (2012). Based on this, companies are shown the possibility of choosing appropriate interest groups during the implementation of the PMO by Inman and Houston (2015) and Todorović (2020).

According to the ISO 17024 standard, which defines competence as "the ability to apply knowledge and skills to achieve intended results" by IPMA ICB (2015) expands this comprehensive definition to that "competency is the set of knowledge, personal attitudes, skills and experience required for the success of certain functions in an organization" (IPMA ICB, 2015). As both of these definitions are aimed at individuals, the question arises whether we can apply them to groups as well. The answer is yes, the concept of competencies can also be applied to groups, i.e. the entire organization (departments, functions, departments, PMO, etc.).

Research on individual competencies can be a starting point for authors for further access to this field. As competencies can be considered at different levels, individual, organizational, strategic or functional, so various authors deal with different levels and link certain competencies to that level.

According to IPMA ICB (2015), individual competencies can be classified into three groups, perspective, behavioral and practice competencies. In this paper, the behavioral competencies will be presented in order to draw a parallel with the organizational competencies that describe the organization for the PMO. According to this framework of competencies, behavioral competencies, competencies related to PMO employees can be divided into:

1. Self-reflection and self-management,
2. Personal integrity and reliability,
3. Relationship and engagement,
4. Personal communication,
5. Teamwork,

6. Leadership,
7. Negotiation,
8. Resourcefulness,
9. Conflicts and crises,
10. Orientation to results.

Based on research conducted by the authors Obradović et al. (2018), individuals and organizations increasingly understand the importance of the soft skills of project managers and invest in their development. Numerous authors (Toljaga-Nikolić et al., 2020) state that the introduction of social, ecological, and economic dimensions into sustainability in project management changes the defined level of responsibility and authority as well as the set of competencies required for a project manager. As other authors state (Wesselink et al., 2015; Silvius, 2020), dealing with numerous challenges from society must be done at the level of the individual or at the level of the board of directors, that is, at a higher level of management. From this comes the fact that if a person does not possess essential competencies at the individual level, it can produce a negative decision for the entire organization. According to a survey conducted by Stojiljković (2022) and based on statistical data obtained from a sample of 303 respondents, 83% of respondents stated that they are focused on effectiveness, that is, doing things the right way. This can be related to the work performance of employees in the PMO, having the same goal.

According to IPMA ICB (2015), the area of individual competencies called "perspective" deals with the context of the project and can be divided into:

- Strategy,
- Structure and process management,
- Compliance with standards and regulations,
- Power and interest,
- Culture and values.

In addition to these IPMA ICB (2015) the area of individual competencies called "practice" deals with the context of the project and can be divided into:

- Designing,
- General objectives, specific objectives and benefits,
- Time,
- Scope,
- Organizing,
- Quality,
- Financing,
- Resources,
- Procurement,
- Planning and control,
- Risk and opportunity,
- Interested parties,
- Change and transformation.

Similar research on competencies was conducted by Singh et al. (2009), according to which the three biggest challenges during the integration of the PMO into the corporation are (1) ingrained corporate culture and failure to manage the organization according to changes (2) lack of experienced project managers (PMs) and PMO executives and (3) lack of an appropriate change management strategy.

Another research using a model from Katz (1974) investigated the skills approach of effective project managers. One of the groups in which he classified these skills concerns conceptual and organizational skills (planning, organizing, strong goal orientation, ability to see the project as a whole, etc.). Organizational competencies are built to serve for better efficiency of the PMO, still, individual competencies take a crucial place in PMO development. Some of the organizational competencies that are essential for the efficient organization of projects are teamwork and communication as stated by IPMA OCB (2013). Recruitment and competency development activities at the organizational level should be based on defined competency requirements communication as stated by IPMA OCB (2013).

According to the ISO 17024 standard, which defines competence as "the ability to apply knowledge and skills to achieve intended results", IPMA ICB (2015) expands this comprehensive definition to that "competency is the set of knowledge, personal attitudes, skills and experience required for the success of certain functions in an organization" IPMA ICB (2015). As both of these definitions are aimed to individuals, the question arises whether we can apply them to groups as well. The answer is yes, the concept of competencies can also be applied to groups, i.e. the entire organization (departments, functions, departments, PMO, etc.).

According to research conducted by Pervaiz et al. (2003), three groups of organizational competence indicators can be classified:

- Customer or market orientation,
- Employee satisfaction,
- Specific/individual competencies.

The standards mentioned here are integrated in all organizational units. Organizational competencies for project management integrate people, processes, structures, resources and align them with the strategic goals of the organization. These competencies should be aligned with the goals, mission, and visions, both at the individual and organizational level, and should follow the defined strategy of the organization. The following division presented by IPMA OCB (2013) organizational competencies are integrated within:

- Management systems,
- Organizational structures,
- Processes,
- Cultures,
- People and teams,
- Resources.

The organizational competencies of project managers in the PMO are improved over time. Some of the external influences that can slow down the process of integration of these

competencies in the PMO are short deadlines, politics, economic factors, social factors, etc. Some of the internal factors that influence the adoption of the mentioned organizational competencies in the organization are the change of organizational culture, templates, procedures. When defining competencies, it is important to determine an adequate set of competencies that will be adopted in the organization.

3. Key Findings

For the introduction of a PMO in an organization to be successful and to achieve the necessary flexibility of the PMO the key drivers are: the organization's readiness for change, the maturity of the organization for project management, the alignment of the PMO with the strategic organizational goals and management system (Abraham et al., 2019).

The economic turbulence that has been happening for the last few years caused by COVID-19 has affected all industries and areas, including project management. Therefore, it is necessary for project managers to know the financial matter and evaluate the budget in order to be able to manage it effectively. PMO activities provide additional investment costs with the intention to create benefits that will significantly exceed the costs. Here, it is necessary that project managers have strong competence, power, and interest in order to know how to manage the budget in the right way.

The next recommendation for improving individual competencies is to renegotiate the defined activities and tasks in the project. When the project starts to run its course, there are many deviations in the form of deadlines, costs, scope, etc. To prevent this from happening, the recommendation for project managers is to approach the project strategically. Also, to re-negotiate with stakeholders for a certain period in order to harmonize all participants in the project, both internal interests and external interests. Sometimes short deadlines that put pressure on the project cannot be changed and project managers working in the PMO are expected to have good persuasive power and know how to negotiate with other project participants who have an interest in the project itself.

One of the frequent problems that arise during the implementation of the PMO is communication between higher and lower levels of management. When delegating tasks by senior management, sometimes there is a misunderstanding. This is a direct result of poor communication. Therefore, managers who are in higher positions should improve their communication skills and know how to delegate tasks well to subordinates.

The book by famous authors Müller and Turner (2017) states the belief that once a project manager learns the tools and techniques, he can apply them to any project, regardless of the knowledge in the field to which the project is related or the characteristics possessed by the manager of the project as well as his leadership styles. Another important point of view (Inman & Houston, 2015) is the fact that over time the PMO becomes a "business dump" where the performance of employees who are not bad enough to be fired, but not good enough for any management responsibility, accumulates. In order for this not to happen, the competencies of the employees must be taken into account during their selection and recruitment for a specific position in the organization. Sometimes it is good to do several rounds of selection in order to choose the right employee for the required

position, and over time you should invest in employees so that they work as efficiently as possible. In the long term, any money invested in improving both the individual and organizational competencies of its employees will return and contribute to better operations of the PMO. As Aubry et al. (2007) say that the PMO is associated with an increasing number of complex projects, the need to acquire new competencies is expected.

In order to improve individual and organizational competencies, the authors state that the need to improve the coordination and control of tasks and resources that the project manager has at his disposal is one of the essential steps toward improving the organization's operations. In addition to this, the availability and relevance of information that is of strategic importance for the PMO is stated; creating a database based on the information obtained; increasing transparency so that everyone in the organization has access to as large a database as possible and in order to adequately solve the problems that arise in the organization, which are based on the lack of communication and transfer of information; increased degree of change and innovation; synergy between defined activities and projects; better definition of project priorities during negotiations in case of crisis situations (Aubryet al., 2007). Many researchers have stated that it is important to adopt individual and organizational competencies at lower levels and build them over time and improve them through numerous situations that employees encounter (Salamah & Alnaji, 2014). According to the literature, one of the most important roles and expected benefits of the PMO is the development of the organization's competencies in project execution. This competence can also be called project management maturity. The cited literature shows that these are precisely the crucial responsibilities of the PMO – promoting competencies in the organization. In recent years, more and more efforts are being made to standardize organizational competencies, in the form of templates for their measurement, determination and integration of the framework for the adoption of organizational and individual competencies, facilitate the promotion of competencies in the PMO (Silvius, 2020).

According to research conducted by Todorović (2020), PMO has a very large influence on project results in as much as 57%. This can be connected with adequate organizational competencies that the PMO should implement in its operations, which relate to management systems and processes. In addition to the organizational competencies, the PMO also distinguishes the individual competencies of the project managers who manage the business. This is proven by this research, to which even 50% of the respondents answered that the project manager is responsible for the results of the project. Thanks to adequate individual competencies possessed by the project manager, and leadership, focus on results and self-reflection will lead to positive results of the organization. All of this leads to the conclusion that, to a large extent, the organizational competencies of the PMO and the individual competencies of project managers who work in the interest of the PMO, and at the same time in the interest of the organization, lead to the fact that, in the long term, the organization will be directed towards the fulfilment of strategic goals in the best possible way.

4. Discussion

Based on the literature review, the difference between individual and organizational competencies in PMO is clearly visible. Individual competencies refer to project managers in the PMO, and to the working team to which project managers delegate tasks. While, on the other hand, organizational competencies are focused on the PMO in terms of templates, procedures, resource procurement and the adopted strategy of the organization in which the PMO is located. Since numerous authors have stated in their papers, it is easier to adapt individual competencies to situations than organizational competencies. That is why individual competencies are easier to manage and adapt to specific situations. Organizational competencies are more difficult to change, but not impossible. Only with timely and well-argued requests, the adaptability of these competencies will be successfully implemented in the organization, and therefore in the PMO. The parallel that is presented in the paper can also refer to the review of competencies that are necessary for the efficient and effective PMO in order to operate in the right way and thus provide positive results for the organization. It is necessary to constantly work with the employees and point out to them the advantages when introducing the PMO into the organization. They should be empowered and encouraged to work for the benefit of the organization by being employees of the PMO, and thus motivate them that the well-being of the organization is also the well-being of the employees. The engagement of employees in working teams that have not previously worked together shows both, organizational competence, and individual competence, teamwork indicates the connection between individual and organizational competence.

5. Conclusions

From this comparative review of the literature, it can be concluded that managing both individual and organizational competencies is not an easy task. The space for developing and improving the presented competencies is based on investment in the organization, and employee's training to benefit from the PMO. The synergy of individual and organizational competencies for the PMO will contribute to better results and improvement of the project management organization's operations. This analysis should encourage the authors to conduct empirical research on this topic and to encourage others to efficiently and effectively use the listed competencies in their organizations.

Conflict of interest: none.

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Study on the Impact of Opening to the Outside World on the Potential of Green Development – An Empirical Test Based on Panel Data from 31 Provinces in China

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Abstract: Based on the provincial level data of China from 2010 to 2020, this paper uses panel fixed effect model, regulatory effect model and semi parametric regression to empirically test the impact of opening up on green development potential. The main conclusions are as follows: On the whole, the relationship between foreign trade and green development potential presents an inverted "U"-shaped nonlinear relationship; The upgrading level of industrial structure and urbanization process play an inverted "U" regulatory role in the impact of import and export dependence on green development potential. This study has strong theoretical and practical significance in promoting high-level opening up, implementing new development concepts and realizing green development under the new situation of international economy and trade.

Keywords: opening to the outside world; the potential of green development; industrial structure; urbanization process

JEL Classification: F12

1. Introduction

Since the reform and opening up, China's economy has developed rapidly and its foreign trade has made remarkable achievements. Based on its strength in labor and natural resource endowment, China's manufacturing industry has actively participated in the international division of labor and become the "world's factory". However, the extensive trade development mode of "big in, big out, two ends out" has led to increasingly serious problems of environmental pollution and excessive energy consumption. In 2009, China surpassed the United States to become the world's largest energy consumer. It now leads the world in air pollutants, mainly sulfur dioxide, sewage and solid waste emissions. As China's economy shifts from high-speed growth to high-quality development, optimizing the economic structure, transforming growth drivers, promoting supply-side structural reform, promoting economic development quality, efficiency and momentum reform, and improving total factor productivity have become inevitable requirements for the new normal of China's economic development (Cai et al., 2008).The new development concept points out the direction and focus of China's development in the future. The 19th National Congress of the Communist Party of China also made it clear that the country's economic development priority has shifted to the development of a green economy, rather than only considering the efficiency of economic growth of the desired output. At the same time, four ministries, including the National

Development and Reform Commission, the Ministry of Commerce, the Ministry of Foreign Affairs and the Ministry of Environmental Protection, jointly issued the Guiding Opinions on Promoting Green Belt and Road Construction. This is also the first time that specific measures on green trade have been elaborated in an important policy document, showing its importance. Green development is a growth approach that considers economic growth, the environment and energy conservation. The potential of green development is based on regional sustainable development, and there is room to improve the level of green development by optimizing the allocation of production factors (Hu & Zhou, 2014). The realization of green development depends on the effective exploitation of green development potential. Therefore, green development potential indicates the sustainability of regional economic development, and can provide strong support for the optimization and upgrading of China's industrial structure and the realization of high-quality and sustainable development.

Foreign trade can exert positive and negative impacts on green development in many aspects through resource allocation (Peng et al., 2013), factor endowment (Fu et al., 2010), financial regulation (Huang et al., 2014), human capital (Yu, 2010), foreign investment (Sheng & Lv, 2012), economic output (Li et al., 2011), etc. Therefore, it is difficult to judge the final impact of foreign trade on the potential of green development emotionally, so empirical research is indispensable. In view of the existing literature, Grossman and Krueger (1995) proposed the environmental Kuznetz curve (EKC) in a pioneering way, arguing that the relationship between environmental pollution level and per capita income is inverted U-shaped, and this hypothesis has been verified by a large number of subsequent studies by scholars. According to Sun et al. (2014), opening to the outside world has a negative effect on green growth, and there are obvious regional differences. In the framework of biased technological progress, Jing and Zhang (2014) investigated the mechanism of environmental control and opening to the outside world affecting green technological progress, and obtained by using panel data regression that the impact of import rate on green total factor productivity was positive, while export rate was negative. Lu et al. (2018) explained the relationship between trade openness, industrial geography and green development by constructing an energy-saving technological progress model. The research results show that there is an inverted U-shaped relationship between import and export dependency and green economic development, while export dependency has a positive promoting effect. Qi and Chen (2018) used the panel smooth Threshold regression (PSTR) model to analyze the impact of environmental regulations on the efficiency of China's green economy. The study shows that there is a nonlinear relationship between opening up and green economy efficiency, and the influence of foreign trade on green economy efficiency turns from positive to negative after the threshold of environmental regulation intensity is crossed. Liu and Ren (2020) analyzed the nonlinear relationship between opening to the outside world and green economy development by using inter-provincial panel data, and the study showed that there was an N-shaped nonlinear relationship between opening to the outside world and green economy development level, with obvious regional heterogeneity.

In general, scholars in the existing studies have realized that there is not a simple linear correlation between opening up and green development, but they have not reached an agreement on the specific nonlinear relationship. In addition, most of the existing researches

are limited to the increment and efficiency of green development, without focusing on "development", and even less focus on "development potential".

In view of this, on the basis of theoretical analysis, this paper constructs a comprehensive evaluation index system of green development potential, uses panel data regression to conduct an empirical study on the relationship between opening up and green development potential, and further tests the regulatory effects of industrial structure and urbanization process. Finally, the robustness of the basic model is verified by semi-parametric regression method and instrumental variable method, which has strong theoretical and practical significance for promoting high-level opening to the outside world, implementing new development concepts and realizing green development under the new international economic and trade situation.

2. Theoretical Mechanism and Research Hypothesis

Based on Talberth and Bohara's (2006) green GDP and open model, this paper constructs a green economic growth model. According to Solow model under closed economy, economic output (Y) is related to factors of production including capital (K), labor (L) and technology (A). Assuming that the per capita output meets the constant returns to scale, there are, i.e. Y = F（K, L,A）

$$Y_t = C_1 A_t^{\alpha} K_t^{\beta} L_t^{\gamma} \tag{1}$$

where C_1 is constant, A_t is green technology progress, K_t is capital input and L_t is labor input, α and β are elastic coefficients greater than 0 and less than 1.

Grossman and Krueger (1991) decomposed the impact of trade on environment into three aspects: scale effect, structure effect and technology effect. For developing countries, the impact of technology effect is the most positive, that is, green technology progress can help developing countries mitigate environmental deterioration in the process of opening up to the outside world to a certain extent (Sun et al., 2014). According to previous literature, green technology progress will be influenced by pure technology progress, degree of openness, industrial structure, urbanization process and other aspects. To simplify the analysis, the relationship between green technology progress and the rate of pure technology progress and the degree of opening to the outside world can be expressed as follows:

$$A_t = C_2 T_t^{\delta_1} O_t^{\delta_2} \tag{2}$$

where C_2 is a constant, T_t represents the rate of pure technical progress, O_t is the openness to the outside world, both $\delta_1 \; and \; \delta_2$ are variables affect the elasticity greater than 0 and less than 1 . Substituting equation (2) into equation (1), we can get:

$$Y_t = C_1 \cdot C_2^{\alpha} \cdot T_t^{\alpha\delta_1} \cdot O_t^{\alpha\delta_2} \cdot K_t^{\beta} \cdot L_t^{\gamma} \tag{3}$$

As can be seen from equation (3), the output of green economy is the result of the combined action of various input factors, which is influenced by technological progress, opening to the outside world, capital input and its elastic coefficient, etc., so there may be a nonlinear relationship.

Further, according to the existing literature, scholars generally pay attention to the moderating role of industrial organizations and urbanization level in the influence of opening up on the level of green development (Managi & Kaneko, 2006; Jing & Zhang, 2014; Zhou & Gong, 2016). According to Ricardo's theory of comparative advantage, sectors with higher relative labor productivity will take the lead in specialized production. Moreover, foreign direct investment, technological progress and the introduction of senior talents mostly affect the tertiary industry, so the upgrading of industrial structure can affect the relationship between them (Liu & Ren, 2020). In addition, with the proposal of Chinese-style modernization, urbanization, as one of the important symbols of modernization level, can promote the transformation of rural surplus population and accelerate the process of urban development and industrialization. But at the same time, it is bound to have a negative impact on resources and environment and increase the pressure of green development. Therefore, it is of practical significance to study the regulating effect of urbanization process on trade opening and green development potential (Yuan, 2018). To sum it up, this paper puts forward the following hypothesis.

- Hypothesis 1: Foreign trade has a nonlinear effect on green development potential.
- Hypothesis 2: Industrial structure and urbanization process play a moderating role in the process of opening to the outside world affecting green development potential.

3. Model Design and Variable Description

3.1. Model Construction

To verify the above research hypothesis, the following panel data model can be constructed to study the relationship between foreign trade and green development potential:

$$GFDP_{it} = \alpha_0 + \beta \sum_n Open_{it}^n + \alpha_1 CONS_{it} + \alpha_2 FINV_{it} + \alpha_3 POPD_{it} + \alpha_4 INF_{it} + \alpha_5 UNE_{it} + \mu_i + v_t + \varepsilon_{it} \quad (4)$$

In model (4), *i* represents the region and *t* represents the year. Open refers to the degree of open to the outside world, and this part it is divided into export dependency (EXR) and import dependency (IMR) respectively. n = 1, 2 is used to explore the nonlinear relationship between foreign trade and green development potential. According to the above, there may be a nonlinear relationship between opening up and green development potential, so this part intends to test the linear and nonlinear relationship between foreign trade and green development level respectively.μ_i is the individual heterogeneity that does not change with time and hard to observe individual heterogeneity. v_t is the time effect. ε_{it} is the random disturbance term.

In order to further test the nonlinear regulating relationship between industrial structure upgrading and urbanization level on opening up and green development level, this part constructs the following regulating effect model by referring to the practice of Lu Fei et al. (2018):

$$GFDP_{it} = \alpha_0 + \beta \sum_n Open_{it}^n + \gamma \sum_n INUS_{it}^n + \theta \sum_n Open_{it}^n \times INUS_{it}^n + \alpha_1 CONS_{it} + \alpha_2 FINV_{it} + \alpha_3 POPD_{it} + \alpha_4 INF_{it} + \alpha_5 UNE_{it} + \mu_i + v_t + \varepsilon_{it} \quad (5)$$

$$GFDP_{it} = \alpha_0 + \beta \sum_n Open_{it}^n + \gamma \sum_n URB_{it}^n + \theta \sum_n Open_{it}^n \times URB_{it}^n + \alpha_1 CONS_{it} + \alpha_2 FINV_{it} + \alpha_3 POPD_{it} + \alpha_4 INF_{it} + \alpha_5 UNE_{it} + \mu_i + v_t + \varepsilon_{it} \quad (6)$$

Where the value of n is 1, 2. If the coefficient of the interaction term is significant, then the moderating effect is present. If the coefficient of the interaction between the quadratic variables is significant, it indicates that there is a nonlinear adjustment effect. The implications of the other variables are consistent with the base model.

3.2. Variable Measure and Description

Explained variable: green development potential. It is difficult for a single index to interpret the content of green development potential. Existing documents have constructed green development indicators from different perspectives (Su et al., 2013; Peng & Wu, 2010; Qian & Liu, 2013; Xue, 2012). This paper draws on the practice of Liao and Huang (2018) to make a comprehensive evaluation of green development potential by constructing an index system of green development potential and using factor analysis method. Based on previous research and data availability, this paper measures the future growth potential of green economy from three dimensions: investment in science and technology education, urban infrastructure and government environmental governance. Table 1 reveals the selection of specific subdivision indicators.

Table 1. Construction of green development potential index system

Target Layer	Guideline Layer	Indicator Layer	Indicator Properties
Green development potential	Investment in science and technology education	Expenditure on science and technology as a share of GDP	positive
		Share of enterprise R&D expenditure in GDP	positive
		Full-time equivalent of R&D personnel (person years)	positive
		Proportion of population with college degree or above	positive
	Infrastructure development	Gas penetration	positive
		Per capita park green space (square meters per person)	positive
		Total urban passenger transport	positive
	Government environmental governance	Expenditure on environmental protection as a proportion of government expenditure	positive
		Proportion of investment in industrial pollution control in GDP	positive

Core explanatory variable: Openness to outsiders. Openness to the outside world is the core explanatory variable of this part. Based on the availability of data and drawing on the practice of Lili et al. (2020), export dependency (EXR) and import dependency (IMR) are used to measure openness to the outside world. Export dependency is obtained by the share of total export trade to GDP, and import dependency is depicted by the share of total import trade to GDP.

Adjust variables. The study of Liu et al. (2020) shows that the relationship between industrial structure upgrading and urbanization process has a nonlinear regulating effect on opening up and green economy development, and green development potential is an important part of green economy development. Therefore, this part believes that industrial structure upgrading and urbanization process will affect the relationship between opening up and green economy development potential. The industrial structure upgrading (INUS) will be measured by the proportion of the total output value of the secondary and tertiary industries in GDP. The level of urbanization (URB) is characterized by the urbanization rate, that is, the proportion of urban population in the total population.

Control variables. In order to control the influence of other factors on the potential of green development, this part draws on previous practices and selects CONS (social consumption scale), fixed asset investment scale (FINV), population density (POPD), inflation level (INF) and urban unemployment rate (UNE) as control variables to be incorporated into the model. Social consumption scale refers to the proportion of total retail sales of consumer goods in GDP. The scale of fixed asset investment is the proportion of fixed asset investment in GDP. Population density is the number of regional population/regional area. The inflation level is measured by the consumer price index.

Based on the availability of data, this paper takes the panel data of 31 provinces and cities in China during 2010–2020 as the research samples, and the data are mainly from China Statistical Yearbook, China Energy Yearbook, China Environmental Statistical Yearbook, China High-tech Statistical Yearbook, etc., and obtained through corresponding calculation and sorting. In order to avoid the influence of extreme values on the study, the variables in this paper were reduced tail by 1% and 99%, and the data after processing were used for subsequent analysis. The data processing software used in this paper is Stata15.1.

3.3. Measure Results and Feature Analysis

Analysis of measure results of explained variables. As shown in Table 1, this paper selected 9 sub-indexes to measure the score of green development potential, and carried out factor analysis with Stata15.1 software. Bartlett sphericity test rejected the null hypothesis that the variables were not correlated, and the value of KMO test was 0.60,indicating that the above variables were suitable for factor analysis.

Figure 1 is the radar map of the mean green development potential scores of 31 provinces and cities in China from 2010 to 2020. It is stratified according to the green development potential scores of each province and city, with the scores increasing from inside to outside.

The same level means that the green development potential is at the same level. It's not hard to spot. Guangdong, Beijing and Jiangsu ranked the top three in terms of green development potential, significantly ahead of Zhejiang, Shanghai and Shandong. The western regions of Tibet, Guangxi and Yunnan have the greatest potential for green development. The radar map shows that the green potential of different regions presents a big difference, with the top green potential mostly in the eastern region and the bottom green potential mostly in the western region.

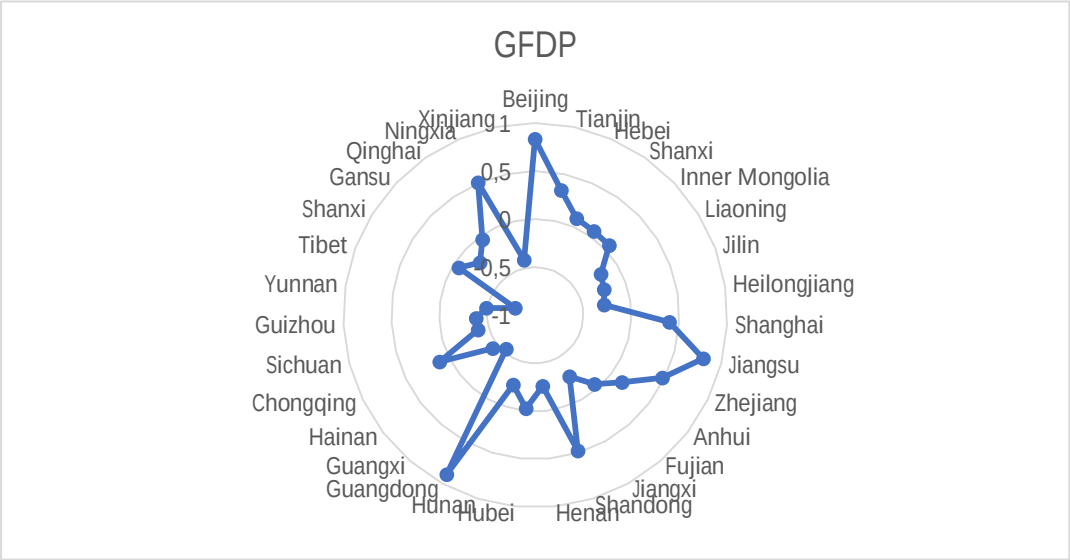

Figure 1. Radar map of green development potential scores

Descriptive statistics and analysis of variables. In this paper, the equilibrium panel observation samples of 341 provinces, autonomous regions and municipalities in China during 2010–2020 were formed. Table 2 shows the descriptive statistical results of the core variables in the paper.

Table 2. Descriptive analysis results

Variables	Obs	Mean	Std.Dev.	Min	Max	Skew.	Kurt.
GFDP	341	-0.003	0.499	-1.033	1.357	0.495	3.019
EXR	341	0.021	0.023	0.002	0.102	1.904	6.199
IMR	341	0.02	0.03	0.001	0.175	3.037	13.028
INUS	341	0.9	0.051	0.751	0.996	-0.265	3.344
URB	341	0.555	0.136	0.237	0.893	0.576	3.552
UNE	341	3.31	0.652	1.31	4.4	-0.873	3.839
CONS	341	0.134	0.053	0.06	0.376	2.069	9.249
POPD	341	0.28	0.117	0.09	0.552	0.637	2.564
FINV	341	10.382	0.479	9.201	11.245	-0.34	2.338
INF	341	1.024	0.015	0.984	1.059	0.203	4.05

Feature fact analysis. Before modeling, this paper first observed and analyzed the linear and nonlinear relationships between opening to the outside world and green development potential through the scatter plot. The left figure in Figure 2 is a linear fitting curve. We find that most points are located near the straight line, indicating that there may be a linear relationship between export dependence and green development potential. The right figure in Figure 2 is a quadratic

fitting curve. It is not difficult to see that the right figure in Figure 2 does not present a complete inverted "U"-shaped curve, and the points are mainly distributed in the left half branch. Combined with the left figure in Figure 2, it can be seen that export dependency and green development potential present a co-direction change relationship, that is, export trade promotes regional green development potential. The left figure in Figure 3 shows the linear fitting diagram of import dependency and green development potential, but when import dependency is greater than 10%, the points are not distributed near the line. Compared with the quadratic fitting curve in the figure on the right, there is an inverted "U"-shaped relationship between import dependency and green development potential, and most of the points are around the estimation of the curve, indicating that the inverted "U" curve can better fit the relationship between import dependency and green development potential than the linear one.

Figure 2. Scatter plots of the linear and quadratic terms of green development potential and export dependency

Figure 3. Scatter plots of the linear and quadratic terms of green development potential and import dependency

4. Model Design and Variable Description

4.1. Benchmark Regression Analysis

Although the relationship between opening to the outside world and green development potential can be roughly inferred in the above scatter plot, the scatter plot does not consider

the influence of control variables, and the graph is often subjective, and cannot truly reflect the causal relationship between opening to the outside world and green development potential. Therefore, OLS estimation of model (4) should be further carried out to control the influence of regional and annual effects. Cluster robustness criteria were used to modify the model for the influence of heteroscedasticity.

Table 3. Benchmark regression results

	(1)	(2)	(3)	(4)
	GFDP	GFDP	GFDP	GFDP
EXR	6.6705***	3.3287		
	(4.6842)	(0.7761)		
EXR2		35.2127		
		(0.8351)		
IMR			4.7175***	12.3399***
			(3.3956)	(4.5986)
IMR2				-52.3700***
				(-3.6496)
UNE	0.0140	0.0143	0.0452	0.0292
	(0.3759)	(0.3827)	(1.1471)	(0.7163)
CONS	1.7402***	1.8068***	0.5061	0.7576
	(3.9509)	(3.9296)	(0.7631)	(1.2142)
POPD	-0.4199**	-0.4205**	-0.3391*	-0.4322**
	(-2.2648)	(-2.2950)	(-1.8773)	(-2.3591)
FINV	0.2268***	0.2431***	0.2315***	0.2394***
	(4.0378)	(4.0116)	(3.7176)	(3.9371)
INF	8.9239**	9.0147**	6.9722	7.2451
	(2.0249)	(2.0675)	(1.5694)	(1.6417)
_cons	-11.7944***	-12.0297***	-9.7599**	-10.1617**
	(-2.6513)	(-2.7302)	(-2.1666)	(-2.2746)
Obs.	341	341	341	341
R-squared	0.5254	0.5269	0.4977	0.5133

T-values are in parenthesis, *** p<0.01, ** p<0.05, * p<0.1

Table 3 shows the benchmark regression results. Equations (1) and (2) estimate the relationship between export dependence and green development potential. Equation (3) and (4) estimate the relationship between import dependence and green development potential. The coefficient of EXR in equation (1) is 6.6705, and passes the 1% significance level test, indicating that export dependence has a significant promoting effect on green development potential. In equation (2), the quadratic coefficient of EXR, EXR2, is positive but not significant, indicating that the nonlinear relationship between export dependency and green development potential is not significant. In equation (3), the IMR coefficient is significantly positive, indicating that the import dependency has a linear relationship with the green development potential. In equation (4), the coefficient of IMR2 is significantly negative, and the coefficient of IMR is significantly positive, indicating that the import dependence on green development potential presents a significant nonlinear relationship, and an inverted "U" shape. From the goodness of fit point of view, the inverted "U" shape has stronger explanatory power for green development potential. From the perspective of control variables, the influence of unemployment rate on green development potential is not

significant, and the scale of social consumption only shows a significant positive impact on the export dependence equation. Population density has a significant negative impact on the green development potential, and fixed asset investment scale has a significant positive impact on the green development potential.

Although the quadratic coefficient in equation (4) is significant, it does not mean that there must be an inverted "U" type relationship, so further extreme point analysis and inverted "U" type relationship test are needed. In this paper, the "utest" command in Stata15.1 software was used for the test. By taking the partial derivative of equation (4) GFDP with respect to IMR, the extreme point is 0.1178, which falls within the 95% confidence interval. Slope has a negative boundary and passes the 5% significance level test, indicating that there is an inverted "U" -shaped relationship between import dependency and green development potential, which can also be verified by the inverted "U"-shaped existence test. The p value is less than 0.05, rejecting the null hypothesis of linearity or "U" type. The inflection point analysis can be further conducted by combining Table 3 and Table 4. The results show that the influence of import dependency on green development potential has an inflection point (0.1178). When the import dependency is less than 0.1178, the import dependency has a significant promoting effect on green development potential. Obviously, the continuous increase in foreign exchange earnings from exports enables the home country to have the financial resources to carry out environmental governance and ecological protection, and enhance residents' "green" happiness. At the same time, a wider participation in international competition will also help improve the efficiency of resource utilization in the whole society. To a certain extent, the increase of trade dependence will promote economic development and improve backward domestic production. However, if it reaches a certain level and fails to realize the "flying geese transformation", the spatial advantage of products will be further solidified, which is not conducive to the realization of green development.

Table 4. Inverted "U"-shaped existence test results

	Lower bound	Upper bound
Interval	0.0008	0.1745
Slope	12.2548	-5.9375
t-value	4.6017	-1.9932
P>t	0.0000	0.0235
Extreme point	95% confidence interval	
0.1178	[0.0924; 0.1731]	
Inverted "U"-shaped existence test	t-value	1.99
	P-value	0.0235

4.2. Robustness Test

Instrumental variable regression. Although the base model controls the influence of regional and annual effects, and selects population density, fixed asset investment, and scale of social consumption as control variables, there may still be endogeneity problems caused by missing variables in the model, resulting in bias in OLS estimation. In order to consider the effects of endogeneity, this paper borrows from previous practices and takes the lag period of export dependency and import dependency as instrumental variables, respectively, and uses the

two-step optimal generalized moment method (GMM2S) to estimate. The lag period of the opening-up level is correlated with the variables of the current period, and the opening-up period of the previous year is not correlated with the perturbation term of the current year, which meets the requirements of the instrumental variables.

Table 5 reveals the GMM2S estimation results of the instrumental variable method. In the first stage, the F statistics were all relatively large, and the unidentifiable test rejected the null hypothesis, indicating that endogenous variables and instrumental variables had a strong correlation, and there was no weak instrumental variable problem. According to the estimation results, the coefficient of EXR is positive at the significance level of 1%, the coefficient of IMR is significantly positive, and the coefficient of IMR2 is significantly negative. The extreme point of 0.1129 can be obtained by obtaining the partial derivative, which is close to the 0.1178 of the benchmark model, indicating that the relationship between opening up and green development potential is consistent with that of the benchmark model after considering the endogenous influence. This indicates that the model is robust to a certain extent.

Table 5. IV-GMM2S estimation results

	(1)	(2)
	GFDP	GFDP
EXR	7.8325***	
	(5.3395)	
IMR		16.0748***
		(5.5950)
IMR2		-71.1893***
		(-4.8086)
UNE	0.0081	0.0211
	(0.2163)	(0.5167)
CONS	1.6848***	0.5345
	(3.7451)	(0.8472)
POPD	-0.4495**	-0.4959**
	(-2.3264)	(-2.5503)
FINV	4.4364	2.3417
	(0.8233)	(0.4285)
INF	0.2609***	0.2830***
	(4.6282)	(4.5405)
_cons	-7.5063	-5.5609
	(-1.3608)	(-0.9920)
Stage one F value	4,328.868	865.594
Unidentifiable test	63.968***	63.232***
area	control	control
year	control	control
Obs.	310	310
R-squared	0.5424	0.5277

T-values are in parenthesis, *** p<0.01, ** p<0.05, * p<0.1

Semi-parametric regression results. Next, the estimation method of the benchmark model was changed, and the robustness test was carried out by referring to the practice of Liu and Sun (2020), which could estimate the dynamic local linear panel data model, and the semi-

parametric model was established with the opening to the outside world as the key explanatory variable. Table 6 discloses the semi-parametric regression results.

Table 6. Semi-parametric regression results

	(1)	(2)
	Export dependence	Import dependency
	GFDP	GFDP
UNE	0.0156	0.0320
	(0.4225)	(0.8167)
CONS	1.8421***	0.9490
	(4.1993)	(1.6118)
POPD	-0.4149**	-0.4299**
	(-2.2817)	(-2.4207)
INF	7.6407***	7.0356**
	(2.7917)	(2.5562)
FINV	0.2326***	0.2352***
	(3.8345)	(3.9472)
G(Open)	--	--
Obs.	341	341
area	control	control
year	control	control
R-squared	0.3988	0.3491

T-values are in parenthesis, *** p<0.01, ** p<0.05, * p<0.1

The kernel regression curves of export dependency and import dependency and green development potential as shown in figure 4 can be obtained by semi-parametric regression. According to the left side of Figure 4, at the significance level of 5%, the regression of export dependency and green development potential kernel density presents a linear upward trend, which verifies the positive promoting relationship between export dependency and green development potential. The right side of Figure 4 shows the kernel regression diagram of import dependency and green development potential. At the significance level of 5%, import dependency and green development potential show a significant inverted U-shaped relationship. After changing the estimation method, the nonlinear relationship between them still exists. Based on the above analysis, it can be seen that the model presented in this paper is robust.

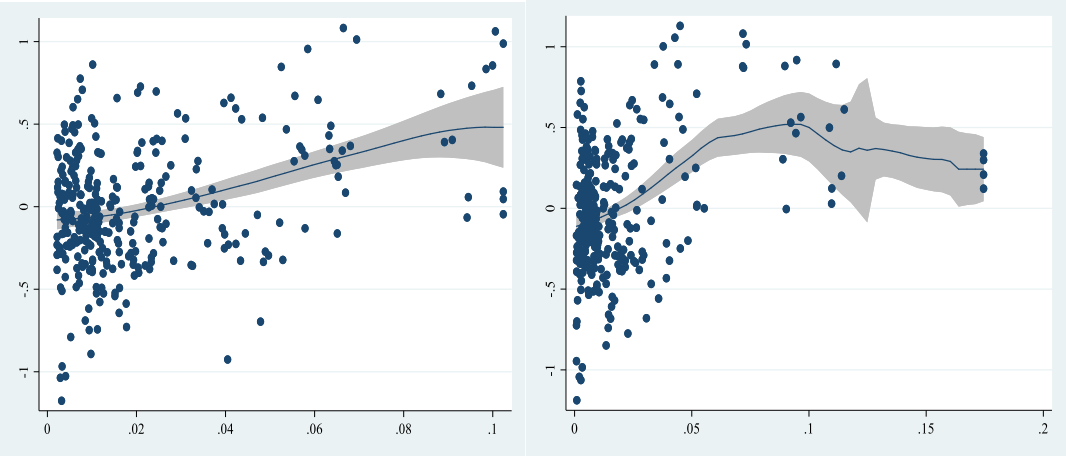

Figure 4. Kernel regression diagram of export and import dependence and green development potential

4.3. Test of Moderating Effect

On the basis of the benchmark model, models (1-2) and (1-3) were further estimated, so as to verify the moderating effect of industrial structure upgrading and urbanization level on the relationship between opening up and green development potential.

Table 7. Test results of the moderating effect

	(1)	(2)	(3)	(4)
	Explained variable: GFDP			
	Export dependency		Import dependency	
	Industrial structure	Urbanization	Industrial structure	Urbanization
Open	-1,804.4862***	-61.2420***	-23.0382	-61.8338***
	(-4.6193)	(-3.9253)	(-0.5052)	(-3.6381)
Open2			970.6891**	559.4452***
			(2.1163)	(5.2068)
INUS	-70.4451***		-3.1871	
	(-4.7300)		(-0.2331)	
INUS2	41.8509***		4.9681	
	(4.9665)		(0.6437)	
URB		-1.1376		5.7763***
		(-0.6072)		(3.2697)
URB2		2.4809		-3.9880**
		(1.6436)		(-2.1681)
Open × INUS	3,882.1329***		24.8318	
	(4.7442)		(0.5400)	
Open × INUS2	-2,083.1701***		-998.2529**	
	(-4.8597)		(-2.1538)	
Open × URB		215.8963***		80.5900***
		(4.6578)		(3.4123)
Open × URB2		-168.8808***		-813.4844***
		(-5.0590)		(-5.3828)
UNE	-0.0058	-0.0053	-0.0141	-0.0314
	(-0.1899)	(-0.1625)	(-0.3637)	(-0.8030)
CONS	-0.1536	0.3566	0.0341	0.9182*
	(-0.3743)	(0.7677)	(0.0674)	(1.8029)
POPD	-0.2726	-0.4890***	-0.3369**	-0.3922**
	(-1.6295)	(-2.8598)	(-2.0155)	(-2.4765)
INF	10.3779***	10.6030***	9.4680***	10.3144***
	(2.9678)	(2.9337)	(2.6683)	(2.7403)
FINV	-0.0147	0.0447	-0.0155	0.0252
	(-0.2565)	(0.6156)	(-0.2445)	(0.3048)
_cons	19.0615**	-11.4694***	-10.5942	-12.5467***
	(2.5114)	(-3.0713)	(-1.4422)	(-3.2488)
area	control	control	control	control
year	control	control	control	control
Obs.	341	341	341	341
R-squared	0.6704	0.6295	0.6537	0.6058

T-values are in parenthesis, *** p<0.01, ** p<0.05, * p<0.1

In equation (1) in Table 7, the interaction coefficient of industrial structure and export dependency is significantly positive, while the quadratic product coefficient is significantly

negative, indicating that industrial structure has a significant inverted U-shaped adjustment effect on the relationship between export dependency and green development potential, that is, when the industrial structure advanced level is lower than a certain level, The upgrading of industrial structure will strengthen the promoting effect of export dependency on green development potential, and when the upgrading level of industrial structure is greater than the critical level, the upgrading of industrial structure will weaken the promoting effect of export dependency on industrial structure upgrading. In equation (2), the interaction term between urbanization level and export dependency is significantly positive, while the coefficient of the secondary interaction term is significantly negative, indicating that the influence of export dependency on green development potential has an inverted "U"-shaped adjustment effect of urbanization process. When the level of urbanization is low, the urbanization process strengthens the promoting effect of export dependency on green development potential, while the high level of urbanization will not be conducive to the positive effect of export dependency on green development potential. In equation (3), the interaction term between industrial structure upgrading and import dependency is positive but not significant, while the coefficient of the quadratic interaction term is significantly negative, indicating that the relationship between industrial structure upgrading and import dependency and green development potential has a nonlinear regulating effect, and industrial structure upgrading weakens each other at the beginning and end of the term. Finally, the influence degree of import dependence on green development potential is weakened. In equation (4), the influence of urbanization level on import dependency and green development potential also has an inverted "U" shape. The results show that too low or too high urbanization level is not conducive to the promoting effect of import dependency on green development potential. Therefore, local governments should promote urbanization step by step, and the urbanization rate should be maintained at a reasonable level. Only in this way can it have a resonance effect with local trade and green development.

5. Conclusions

This paper empirically analyzes the relationship between opening-up and China's green development potential by using panel data from 31 provincial levels in China from 2010 to 2020 as samples. The results show that there is an inverted U-shaped nonlinear relationship between foreign trade and green development potential. The influence of import dependency on green development potential has an inflection point (0.1178). When import dependency is less than 0.1178, import dependency has a significant promoting effect on green development potential. After crossing the critical value, import dependency has a significant negative effect on green development potential. When the adjustment effect is considered, the relationship between the import and export dependency of the industrial structure and the green development potential has a significant inverted U-shaped adjustment effect, that is, when the industrial structure advanced level is lower than a certain level, the industrial structure advanced level will strengthen the promoting effect of the export dependency on the green development potential, when the industrial structure advanced level is greater than the critical level, the upgrading of industrial structure will weaken the promoting effect of

export dependence on the upgrading of industrial structure. The influence of import and export dependence on green development potential also has an inverted U-shaped moderating effect of urbanization process. When the level of urbanization is low, the urbanization process strengthens the promoting effect of export dependency on green development potential, while a high urbanization level will not be conducive to the positive effect of export dependency on green development potential. In view of the above conclusions, this paper puts forward the following policy suggestions: First of all, the development of foreign trade should be under the leading role of the government, grasp the evolution difference between it and the green development potential, and control the openness to the outside world within a reasonable level, in order to promote green development. Secondly, the empirical results show that the upgrading of industrial structure will strengthen the promoting effect of opening up on green development potential, but when it exceeds the critical level, it will play a reverse effect. Therefore, overall planning and allocation should be made to control the industrial structure at a reasonable level. Finally, we should grasp the urbanization process well and give full play to its regulating role in the process of opening up affecting the potential of green development.

Conflict of interest: none

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Water Shortage in Polish Agriculture and Its Economic Consequences

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Abstract: Water is a key factor in the development of agricultural production, both for crops and animals. Poland, one of the main producers of agricultural produce and foodstuffs in the European Union, is regarded as belonging to the group of countries with poor water resources, with the country more frequently experiencing droughts in recent years. This paper presents an overview of the issue of water management in Polish agriculture and the possible consequences of changes in this area as a subsystem of the national economy – agribusiness. The principal source of data for the analyses was information from public statistics and the State Research Institute of Soil Science and Cultivation (IUNG-PIB). The analyses show that there is an urgent need for changes to the approach to water shortages in agriculture at various levels of decision making, both with regard to agricultural policy as well as in the behaviour of farmers. The connections described here can serve as a basis for more comprehensive economic research in the field of water usage in agriculture.

Keywords: climatic changes; agricultural drought; agribusiness; agriculture; Poland

JEL Classification: Q15; Q54; R11

1. Introduction

Water is the most precious natural resource and plays a leading role in the life of humankind and the natural environment. From an economic point of view, water fulfils its special role both for the individual and for households (for drinking, cooking and cleaning), as well as in many areas of production and services in the national economy. Among the sectors and branches of industry in which water is of key importance in economic processes are agriculture and heat and electricity production (hydroelectric plants, water used to cool reactors, etc.) (Piwowar & Dzikuć, 2022). On a global scale, it is agriculture that uses the most water resources (around 70-80% of global water resources) (Crovella et al., 2022; Bazilian et al., 2011). There are of course many other sectors in which water is used as a raw material for production or as an environment for production processes. The subject of consideration in this article is the use of water resources in agricultural production, a key aspect to which is the noticeable shortage of water resources in Poland, both as a whole and in agricultural processes. In recent years in particular, low total rainfall has coincided with high temperatures, which has had a negative effect on the volume and quality of crops (Żmudzka, 2004). Meanwhile, due to ever more favourable conditions, opportunities are being created in Poland for the growing of plants that require high temperatures (Koźmiński et al., 2021).

This paper relates to the territory of Poland, a country that is of significant importance in terms of agricultural production in the European Union, especially in the production of

cereals, rapeseed, sugar beet, apples, poultry, pork and milk (Firlej et al., 2015; Szajner & Szczepaniak, 2020). Agricultural production requires a large amount of water, and the principal source of water for crops is atmospheric precipitation. The amount and type of precipitation varies considerably over time and geographical location. The climatic changes currently observed in Poland consist of a rise in temperatures and the more frequent occurrence of extreme phenomena. Rural areas are therefore faced with serious challenges in terms of adapting to the effects of climate change. According to data from the Institute of Meteorology and Water Management in Warsaw, in the years 1951-2020, there was a statistically significant increase in the average annual air temperature (at a significance level of 0.05), with a rising trend of 0.29 °C per 10 years. This translates into a rise in temperature in the period given (since 1951) of 2.0 °C (Klimat Polski, 2021). In addition, especially in recent years, there have been periods of very high temperatures in the summer months. In combination with relatively low rainfall (and other unfavourable changes from the point of view of agriculture, including snow-free winters), these have had an unfavourable effect on agriculture, especially the growing of crops. What is more, as indicated by Grillakis (2019), drought conditions are expected to worsen in Europe, especially in Eastern Europe and the Mediterranean Basin. Poland belongs to the group of countries with few water resources in comparison to European countries in general. It is estimated that the total amount of water flowing into the Baltic per Polish citizen per year is just under 1,600 m3, that is almost three times less than the average inhabitant of Europe (around 4,600 m3) (Florek et al., 2017).

The topic of water management in the Polish agricultural sector is being addressed ever more frequently in the subject literature, especially in the context of improving water retention and flood protection. The issue of making rural areas in Poland more resilient to climate change, amongst others by land consolidation, was the subject of an analysis by Stańczuk-Gałwiaczek et al. (2018). There are also many studies in this field concerning microbiology, plant physiology and agronomy, including the dependencies and effects of changes to soil humidity on soil biology, and changes in the quality and quantity of crops (Brzozowski & Stasiewicz, 2017; Siebielec et al., 2020). Interesting research in this field has also been conducted into the development of energy crops in Poland, e.g. a study by Liberacki et al. (2022) into the conditions for the development of willow for energy purposes in the west of Poland. This is an important issue, as development of such production and greater use of biomass for energy needs (e.g. as part of agricultural biogas plants) is one of the key elements in ensuring energy security for Poland based on renewable sources (Bielski et al., 2021; Piwowar et al., 2016). Meanwhile, Piwowar et al. (2021) and Kuczyńska et al. (2021) addressed issues related to unfavourable changes in water pollution due to agricultural activity. However, very little space is dedicated in the subject literature to the problem of scarcity of water resources and its effect on agriculture, as well as in the context of mutual linkages within agribusiness.

It is also worth underlining that not only the production of crops requires a suitable supply of water, but also animal husbandry. The water footprint for slaughter livestock (the main category in livestock production in Poland) is dependent above all on the type of fodder and the effectiveness of animal production (Florek et al., 2017). In the rearing and breeding

of animals, water from precipitation and watering are used to produce fodder, in addition to water used for drinking and maintaining livestock.

The principal aim of this paper is to identify problem areas that may appear along with the deepening problems related to water shortages in agriculture in Poland. Taking into account the scarcity of such papers in the subject literature, this paper fills this gap by providing a broad view of the issue in question in the context of the development of agribusiness. As such, this article is a synthetic exploration of new tendencies in this research field.

2. Methodology

This paper uses the following research methods: monographic/descriptive methods, analyses and syntheses, induction and deduction. Data concerning current problems related to drought affecting agricultural crops in Poland was obtained from the Agricultural Drought Monitoring System (acronym SMSR in Polish). This system uses the climatic water balance (CWB) and the regional variability of soil conditions to assess the threat of drought. The CWB expresses the difference between atmospheric precipitation and potential evapotranspiration. Climatic water balance values are calculated for subsequent sixty-day periods on the basis of meteorological station readings (synoptic stations and precipitation gauges belonging to the Institute of Meteorology and Water Management – IMGW). This system was developed by the Institute of Soil Science and Cultivation for the Ministry of Agriculture and Rural Development. The system is designed to indicate areas that have suffered losses caused by drought to crops covered by the 'Act on subsidies for the insurance of agricultural crops and livestock in Poland' (SMSR System). This paper presents the results for the most important agricultural crops in Poland in terms of the largest sown areas – cereal crops, as well as rapeseed and agrimony.

3. The Scale of the Problems of Water Shortages in Polish Agriculture and its Possible Consequences for Agribusiness

Analyses of the threat of drought in Poland have shown that 55.64% of the territory of Poland is under serious threat of drought. Areas at the highest, most extreme threat level cover close to 5% of the country (State Water Holding Polish Waters, 2022). The threats to agricultural production in Poland are evidenced by water shortages for crops, which are calculated as the difference between evapotranspiration and atmospheric precipitation, taking into account soil retention (Mioduszewski, 2012). The latest information from the Agricultural Drought Monitoring System (acronym SMSR in Polish) shows that in Poland in the years 2020-2022 there was a worsening of the phenomenon of water shortages in cereal and rapeseed crops (Table 1). Cereals are the most important group of crops in Poland. The sown area in Poland in 2021 was 10.9 million hectares, with a domination of cereals (68.4% of the total sown area). Rapeseed crops covered about 1 million hectares in Poland in 2021 (Agriculture in 2021, 2022). Polish public statistics includes the joint production of rapeseed and agrimony, of which the decided majority is winter rape.

Table 1. Drought in Poland for cereal and rapeseed crops in the years 2020-2022

Details	Spring cereals			Winter cereals			Rapeseed and agrimony (spring, summer)		
	2020	2021	2022	2020	2021	2022	2020	2021	2022
Number of communes with drought	922	1,115	2,096	761	733	1,909	247	1,212	1,734
% of communes with drought	37.22	45.01	84.62	30.72	29.59	77.07	9.97	48.93	70.00
% of arable land with drought	12.34	14.30	38.17	8.93	8.32	25.19	2.52	13.12	20.97

The data presented in Table 1 shows that the problem of water shortages affects extremely large areas of cereal and rapeseed production in Poland. According to reports by the IUNG-PIB, considerable areas of rapeseed crops suffered from water shortages in the Lubelskie voivodeship (the region that has the second largest area of rapeseed crops after the Dolnośląskie voivodeship). Detailed information on crop losses in individual voivodeships and communes are available on the Agricultural Drought Monitoring System website (SMSR System).

Drought is a natural phenomenon and cannot be completely eliminated. However, action can be taken to limit its influence on the level of agricultural production, and to counteract its effects. This action, taken at the level of agriculture and rural areas, is extremely important taking into account its effects on other areas of agribusiness (Figure 1).

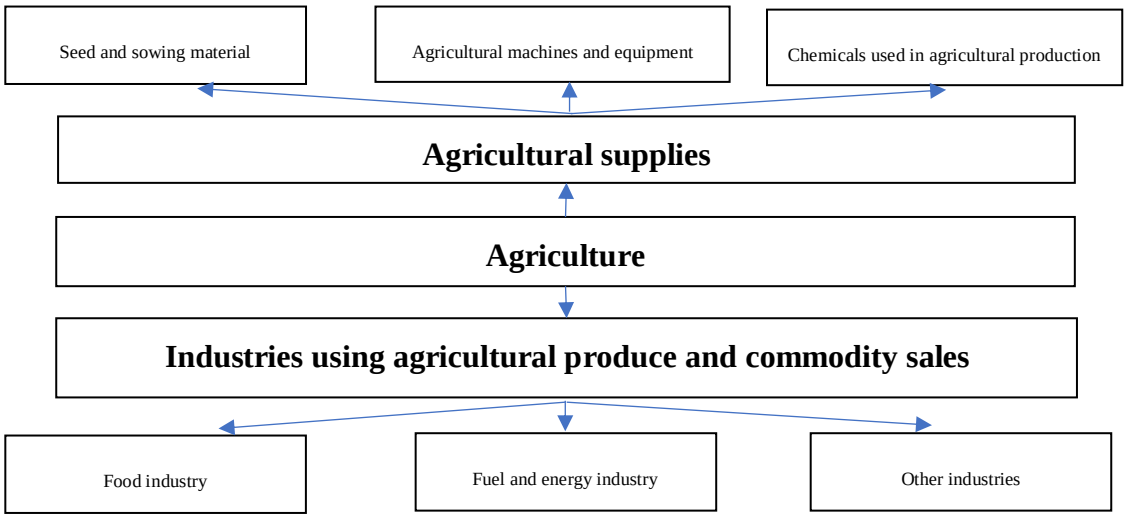

Figure 1. Selected areas experiencing problems connected to water shortages in agriculture

Water shortages in agricultural production will result in changes (both in terms of quantity and quality) for the whole agribusiness sector. Agricultural producers to an increasing degree will have to pay attention to the selection of species and varieties for which water stress will not be a key factor in limitations on the size and quality of crops. Generally, plant needs are expressed using the transpiration coefficient, which determines the amount of water used (transpired) in kilograms or in litres calculated for 1 kilogram of dry plant mass. Plant varieties that use C4 photosynthesis (including corn) use less water to form a crop,

while the most popular crops in Poland (which use C3 photosynthesis) use more water. On the one hand, a rise can be expected in the production of heat-tolerant plants (e.g. sunflower, soya and corn), while on the other hand, new varieties will be developed and implemented of plants currently grown, but with better parameters regarding water stress (higher tolerance to water shortages). This will be linked to changes to other elements and agrotechnical processes (including the varieties and types of fertilizers and pesticides used, as well as the agricultural machines and equipment used). Changes in the field of agricultural supplies for production will move in the direction of the development of products that stimulate the growth and development of plant root systems. Balanced fertilising with phosphorus and potassium will be highly important (development of the root system, correct water management). There may also be an increase in the use of no-till conservation systems (including aggregates for strip-till).

Water shortages will also affect the quantity of livestock production. In this case, the effect will be the result of the linkages between crop and livestock production (production of fodder), as well as keeping livestock as a part of industrial farming. In terms of meadows and pastures, there will be a problem with several windrows. In meadow and pasture farming, optimal water levels affect the quality of meadow and pasture fodder, which translates into the productivity achieved in livestock production. What is more, these levels are the basis for development in low-cost production systems (e.g. ecological animal husbandry), and are a key factor in limiting threats and ensuring an equilibrium in the natural environment (Burczyk et al., 2018). Meanwhile, intensive animal production requires very large water resources, especially for the production of beef and pork. The water footprint for meat increases depending on the type, with the lowest being for poultry, followed by pork, mutton and then beef (Mekonnen & Hoekstra, 2012). These variabilities are explained by the difference in the fodder conversion coefficient. Ruminants (cattle, sheep and goats) have a low fodder conversion coefficient in comparison to monogastric animals (poultry and pigs) (Ibidhi & Ben Salem, 2020).

As underlined above, water shortages can have an influence on the structure of sowing (type and category of crops, changes in areas of sowing/planting for particular groups of use/varieties). This in turn may be a challenge in terms of new knowledge that is required for conducting proper agrotechniques for the development of crops e.g. soya (currently, the sown area in Poland is around 25,000 hectares). There will also be changes in the times of agrotechnical processes, e.g. adapting sowing dates to thermal and humidity conditions, and using varieties with shorter vegetation cycles that are more resistant to water shortages. These changes must take place not only in the agrotechnical sphere (in addition to those mentioned earlier, e.g. greater use of organic fertilisers, introducing catch crops) and in new investments in watering infrastructure, but also in general agricultural practices that encourage the infiltration and retention of water in the soil in rural areas.

Changes to the production of agricultural produce will be transmitted to the processing industry. The largest recipient of agricultural produce is the food industry, therefore every change to crop sowing practices (and consequently harvests) will have a direct effect on the foodstuffs available to processing plants. This raw materials barrier, which may appear due

to a decrease in the supply of agricultural produce, will limit production capability and the currently high levels of food exports, and will result in a growth in imports (e.g. of cereals and oil-rich plants), and as a consequence worsen the balance of foreign trade in agricultural produce and food. The changes may affect not only the food industry, but also other industries in which agricultural produce is processed (e.g. for biofuel or biocomponents). There will also be changes to the trade in commodities in the agribusiness sector, especially in the context of adapting to the current and future needs of the agri-food industry and consumer (social) needs.

4. Summary

Changes in the climate not only have an effect on actions undertaken in the field of agriculture, but also on all other areas of agribusiness. Agriculture is connected to other sectors both on a functional and production level, and as a result, any changes to agriculture have consequences for the remaining sectors (supplies, industry and trade). The importance of water is therefore crucial not only for the agricultural sector, but also for other production and service sectors of agribusiness. The problem of water management in agriculture is complex, as both a shortage of water as well as excessive use of water (waste) lead to social, environmental and economic problems, the consequences of which reach beyond the scope of agricultural activity in a given region. These consequences are felt over a considerably larger geographical area as well as in the activity of related enterprises (the production and distribution of agricultural supplies, plant nurseries, the food industry, gastronomy, trade, etc.).

Changes in agriculture due to the warming of the climate require both the adaptation of agricultural production to the new conditions (selection of species/varieties, times of sowing, new threats related to plant diseases, pests, etc.), as well as the design of new solutions in rural areas to improve water retention and for flood protection. The current issue of the scarcity of water resources in agriculture must take into consideration the context of sustainable development, and the existence of more complicated and complex relations than previously anticipated, for example for the issue of water footprint (e.g. the issue of taking into account the import and export of fertilisers, fodder, etc.) make it difficult to make comparisons in this domain. It is also vital to better understand how water stress affects long-term growth and crops, which can be the basis for new research initiatives into plant modification, crop rotation, agrotechnical processes etc. A change is necessary in the approach of agricultural producers, and particular attention should be paid to the issue of the availability of water. Climate change will force new initiatives to be undertaken in terms of switching from growing water-absorbent species/varieties in favour of those which use water resources to a lesser degree. This can be followed up by a system of financial incentives (e.g. in terms of changes in the direction of crop production instead of the action currently taken), as well as implementing economic instruments to water and agricultural policy, including those referring to internalisation of the external effects of agricultural production on the availability of water. Changes to water management in agriculture and rural areas will generally require a variety of socio-economic and environmental compromises.

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Interrelations between Digital Development and IT & Hi-Tech, R&D sectors, Labor Market in EU Countries

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Abstract: The paper presents a methodical approach to analyzing the interrelations of the digital development indicators and the indicators of IT & Hi-tech and R&D sectors as well as the labor market. The authors of the article have conducted analyses of the interrelations of the digital indicators and the indicators of IT & Hi-tech, R&D sectors as well as the labor market. Based on canonical correlation analysis, the results of the research have proved the existence of a stable correlation between the indicators of each pair. The regional peculiarities of EU countries of the relations between the analyzed groups of indicators for the period 2016-2020 were singled out; namely most of Eastern European countries were placed below the average European level while Scandinavia and Northern Europe belonged to the group of leading countries. The results of the interrelations between digitalization indicators and indicators of the IT & Hi-tech, R&D sectors as well as the labor market made it possible to draw conclusions regarding the choice of directions for digital government policy.

Keywords: digitalization; IT sector; research and development; labor market indexes; canonical correlation analysis; EU countries

JEL Classification: J24; O14; 032

1. Introduction

Digitization and transformation of business processes is essential for any company that wants to grow and succeed in a rapidly digitalizing business environment. At the same time, automation can lead to significant changes in the structure of the labor market. Many leading companies use digital solutions and artificial intelligence to increase productivity and to optimize the production process. According to PricewaterhouseCoopers (Rao & Verweij, 2017), artificial intelligence is becoming a major trend in the global market. The level of GDP will increase threefold (+14%) by 2030 due to implementation of artificial intelligence. The development of digital technologies, such as IoT, mobile or Internet technologies promote the further progress in the IT & Hi-tech sector. In consideration of the foregoing, it becomes obvious that digital transformation needs to be managed. Effective digitalization management is possible on the basis of a thorough analysis of the interrelations of digitalization with the main indicators of the R&D, IT & Hi-tech sectors, as well as labor market.

2. Theoretical Part

Numerous scientific papers, as well as regulatory documents, recommendations of national and international agencies are devoted to the development of digital technologies.

A number of programs for the development of digital technologies have been implemented at the European Union level. For instance, Digital Europe program (Regulation (EU), 2021) is focused on building the strategic digital potential of the EU and promoting the wide deployment of digital technologies. Special attention is paid to the development of the science and innovation sector and digital technologies as a basis for ensuring competitiveness at the global level and strategic autonomy of the EU (European Commission, 2020). A significant number of scientific papers are devoted to the analysis of digital indicators. Kotarba et al. (2017) analyzed the indicators used to measure digitization activities at the level of the economy to society, industry, enterprise, as well as customers. The authors conducted the detailed comparative analysis between the indicators' metrics and their components.

The basic indicator for determining the level of digital development in EU countries is the integrated indicator of DESI. Data of the report (European Commission, 2021) show that the IT sector has higher labor productivity and the IT sector grew faster during 2006-2018. Labor productivity in the IT sector in the EU is at a high level, but lower than in USA. Therefore, such important sectors as R&D, as well as the sector of information technology and high-tech production should become a priority while their analysis and correlation with digitalization requires further research.

Many authors conduct a comparative analysis of EU countries regarding their progress in the direction of digitalization, using different methodological approaches. Becker et al. (2018) conducted a study of the use of ICT technologies in the countries of Central Europe on the basis of a multi-criteria ANP-based analysis.

A number of works focuses the digital impact on sustainability. The authors (Jovanović et al., 2018) investigated how EU digital indicators affect the main components of sustainable development: economic, social and environmental, based on correlation analysis. While Polozova et al. (2022) pointed out that according to the radical technological changes the approach to the assessment of investment attractiveness require a significant transformation.

Kergroach (2017) explored the impact of digital technologies on the labor market and concluded that ensuring the adaptability and efficiency of the labor market is a necessary prerequisite for social stability and security.

Studying the impact of digital technologies on the poverty level of the population in EU countries Kwilinski, Vyshnevskyi, and Dzwigol (2020) found that in most cases countries with a higher level of digitalization showed a more significant reduction in the level of poverty and social isolation.

During their analysis of the digitization level of the economy and society, the authors (Zaharia et al., 2020) conducted a cluster analysis of EU countries considering the DESI index, as well as the level of education and life satisfaction of the population. Based on the results of the analysis, the authors presented the EU countries according to the relevant clusters. This approach makes it possible to determine the tools of state regulation to ensure the functioning

of the single digital market. Cluster approach was also used in the research (Polozova et al., 2021) to analyze the impact of digital technologies on the level of competitiveness of the countries.

The authors in the research (Vrabcova & Urbancova, 2022) analyze the activities of organizations in the context of human resource management. Authors proved that the greatest effectiveness of cooperation between all age categories of employees consists in improving the motivation and productivity of employees (67%).

The authors (Georgescu et al., 2022) evaluated the relationship between the economic growth and digitalization in the EU-27 countries through a canonical correlation analysis, and concluded that digitalization provides 70.33% of economic growth, but also resource productivity depends on a high level of digitization. Therefore, it is necessary to investigate the degree of interrelations between indicators of digitalization and indicators of labor market development in more detail.

An analysis of scientific research and the general trends of digitalization made it possible to determine the insufficiency of the research on the relations between digitalization, the IT & Hi-tech sector, the R&D sector, and labor market.

The purpose of the research is to explore the nature of the interrelations between the digital development and the R&D, IT sectors as well as labor market.

2. Methodology

The approach applied in the conducted analysis is presented in Figure 1.

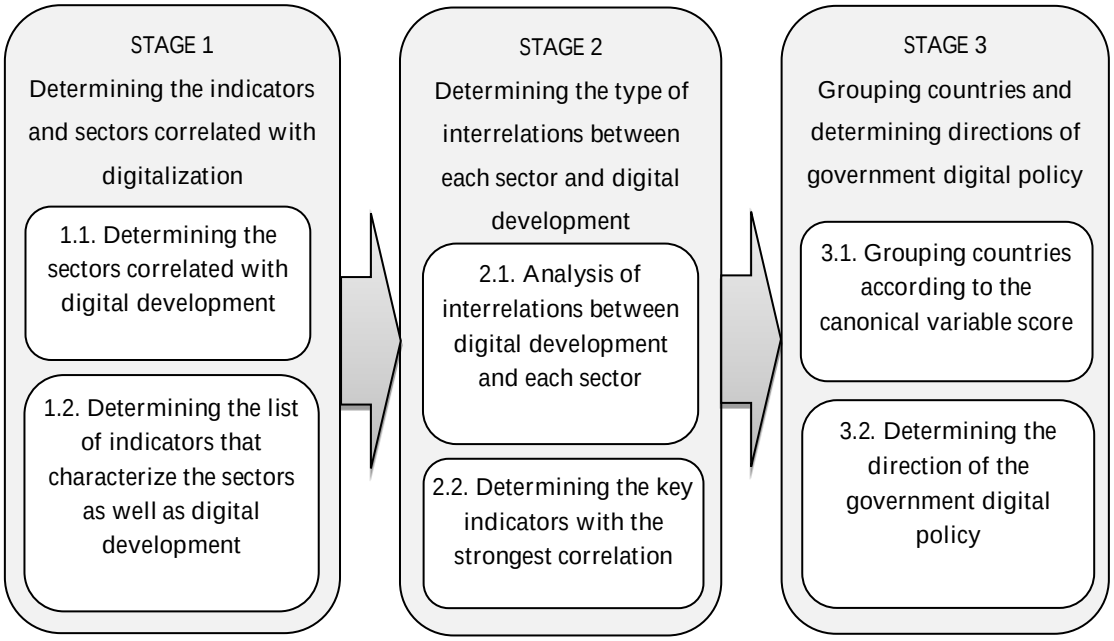


Figure 1. Scheme of the methodical approach to analyzing the interrelations between the digital development and IT & Hi-tech, R&D sectors, and labor market

To conduct the research, the data was grouped in 4 categories: digital development indicators; indicators of R&D sector; indicators of IT & Hi-tech sector; and labor market development indicators. The detailed compositions for each group of indicators as well as descriptive statistics are presented in Table 1.

Table 1. Variables used and their descriptive statistics

Group	Name	Description	Valid cases	Mean	Min	Max	STD
Indicators of digital development	HSIC	High speed Internet coverage, % of households	140	45.3057	0.0000	100.000	26.9719
	FBC	Share of households, that have fixed broadband connection	140	74.5071	55.0000	98.000	10.1425
	IntUs	Internet users, percentage of population	140	85.0214	62.0000	99.000	8.2326
	Mobsub	Mobile subscribers per 100 inhabitants	140	122.6571	99.0000	153.000	12.3666
	DSbasic	Percentage of individuals with basic or above basic overall digital skills	140	55.6571	26.0000	86.000	12.8560
	Ecom	Value of E-commerce sales, percentage of turnover	140	16.7786	4.0000	44.000	7.9640
Indicators of R&D sector development	GERD	Gross domestic expenditure on R&D, % of GDP	140	1.6596	0.4400	3.490	0.8748
	lnBERD	Business enterprise expenditure on R&D, Euro per inhabitant	140	5.3417	2.6174	7.069	1.1745
	HRST	Share of scientists and engineers in labor force, %	140	7.3914	3.2000	12.300	1.9956
	JobMob	Job-to-job mobility in R&D sector, % of labor force	135	6.8407	1.4000	11.600	2.3966
Indicators of IT & Hi-tech sector	ITGDP%	Share of IT sector in GDP, %	112	4.8094	1.9600	13.400	1.9927
	HTExp	Exports of high technology products as a % of total exports	140	12.2250	4.0000	42.500	7.0445
	ITstaff	Employed ICT specialists, in % of total employment	140	4.0579	1.8000	7.600	1.2546
	ITvacant	Job vacancy rate for Information and Communication sector	135	2.5393	0.3000	6.600	1.4967
Indicators of labor market	Indicators	Total unemployment rate, percentage of active population 15-74 years	140	7.2400	2.0000	23.600	3.7750
	Lcost	The total hourly labor costs, Euro	140	103.3764	89.1000	127.300	5.7460
	Lprod	Real Labor productivity per person, index 2015 = 100	140	22.2164	4.5000	45.300	12.0833
	Gen_pg	Gender pay gap, in % of average gross hourly earnings of male paid employees	140	13.0479	0.7000	24.900	5.4723

The research was conducted on the data of EU countries for 5 years (2016-2020). Due to the large root mean square deviation of the values of the real indicator BERD (R&D sector) modification was made, and the natural logarithm was taken. The same approach is used by Heidy (2020), Park (2019). There are no values for the indicator of the share of the IT & Hi-tech sector in GDP (ITGDP%) in 2020. The values of individual indicators are also missing for two countries: the IT vacant indicator is not available for France, and the JobMob indicator is missing for Ireland. According to that, the smaller sample of determined indicators is taken.

Canonical Correlation Analysis (CCA) used to analyze the correlation between two sets of data was chosen for the research. Thus, to fulfill the research objectives, it is necessary to

perform the CCA procedure three times to analyze the correlation of digital development indicators with each of the three sectors separately. When comparing CCA with the principal component method (PCA), the choice has made in favor of the first method: while PCA focuses on finding linear combinations that account for the greatest variance in one data set, CCA focuses on finding linear combinations that account for the greatest correlation in two data sets. It corresponds to the intended purpose (Härdle & Simar, 2015).

Data sources were Eurostat. The calculations were made using the Statistica software.

3. Results

To use CCA, it is necessary to follow the rules of a close to normal distribution of variables in the general population, a sufficient length of the sample, and the absence of significant outliers among the population of analyzed values. Statistica uses the Kolmogorov-Smirnov Test to determine the closeness to a normal distribution.

Stevens (2009) recommends that there be at least 20 times more cases than variables in the analysis to obtain reliable estimates of canonical factor loadings. The number of indicators in the largest sample is 6 (Table 1), and the sample length exceeds 6 × 20 = 120 cases, which corresponds to the condition of sufficient sample length.

When analyzing indicators of two groups, CCA creates canonical roots (variates) with each as a linear combination of indicators included in the analyzed groups that have the highest possible correlation. If two groups with different numbers of indicators are compared, the number of roots (variates) is equal to the smaller number (Andrew et al., 2013; Fan, 1996). In presented research, the number of canonical roots is equal to 4 for three pairs of indicators: Digital + R&D, Digital + IT & Hi-tech, Digital + labor market. As with PCA, the first root is the most significant.

According to the results of the calculations, it was found that the overall canonical R is quite significant (> 0.85) and very significant ($p < 0.0001$). Canonical R, indicated in the first line of each section in Table 2, refers to the first and most important canonical root (variate). This value can be interpreted as a simple correlation between the weighted sums of the scores in each set with the weights belonging to the first (and most significant) canonical root. Significance is checked by Chi2 test and p-value test. According to the data presented in Table 2, the results of the first two most important roots (variates) are significant.

CCA of the digital sector with the three investigated groups (sectors) of indicators determined that the significant correlation with the first root (variate) has following digital indicators (Table 3):

- in the R&D sector: DSbasic (negative correlation), IntUs (negative correlation), FBC (negative correlation), Ecom (negative correlation);
- in the IT & Hi-tech sector: DSbasic, IntUs, Ecom (for all: positive correlation);
- in the labor market: IntUs, DSbasic, Ecom, FBC (for all: positive correlation).

According to the canonical weighting coefficients in the analysis of relations with R&D and IT & Hi-tech, the only significant indicator is, however, the share of the population with a basic or higher than basic level of digital skills. The rest of indicators of digital development

Table 2. Common canonical correlation coefficient and test of significance of estimates

Root removes	Canonical R	Canonical R^2	Chi^2	Df	p	Lambda Prime
Digital development and R&D sector						
0	0.853043	0.727682	267.8262	24	0.000000	0.124400
1	0.658012	0.432979	100.6751	15	0.000000	0.456821
2	0.422688	0.178665	27.7695	8	0.000522	0.805651
3	0.138186	0.019095	2.4775	3	0.479386	0.980905
Digital development and IT&Hi-tech sector						
0	0.869702	0.756382	217.4879	24	0.000000	0.117333
1	0.685472	0.469872	74.1544	15	0.000000	0.481627
2	0.243963	0.059518	9.7389	8	0.283877	0.908510
3	0.184379	0.033996	3.5106	3	0.319412	0.966004
Digital development and Labor market						
0	0.859821	0.739293	232.7531	24	0.000000	0.174913
1	0.473332	0.224044	53.2815	15	0.000004	0.670915
2	0.326298	0.106470	19.4181	8	0.012796	0.864630
3	0.179844	0.032344	4.3893	3	0.222406	0.967656

Table 3. Factor loadings and canonical weights of digital development indicators with the 1st root

Relation with	Root 1 structure	Variables of digital development					
		HSIC	FBC	IntUs	DSbasic	Mobsub	Ecom
R&D	Factor loading	-0.018	-0.66	-0.901	-0.959	-0.144	-0.624
	Canonical weight	0.105	-0.138	-0.292	-0.565	-0.023	-0.163
IT & Hi-tech	Factor loading	0.011	0.531	0.929	0.937	0.137	0.638
	Canonical weight	-0.051	-0.078	0.357	0.558	0.050	0.283
Labor market	Factor loading	-0.052	0.529	0.923	0.889	0.017	0.591
	Canonical weight	-0.244	-0.089	0.721	0.359	-0.107	0.088

with a significant level of correlation (IntUs, Ecom, and FBC) have low weighting coefficients. When analyzing the correlation with the labor market, there are two significant and weighty indicators: the level of digital skills, as well as the share of Internet users. The rest of indicators with a high factor loading (Factor loading) but a low weight coefficient (FBC, Ecom) do not take a significant part in influencing the indicators of the group to which they are compared. Two indicators of digital development, HSIS and Mobsub, have a low canonical correlation coefficient and a low weight coefficient: they determine the second, third and fourth canonical variables (roots).

Table 4 indicates the factor loadings and weighting coefficients for three sectors of indicators when conducting the CCA procedure between them and indicators of digital development.

The results of the calculations of factor loadings and canonical weighting coefficients (Table 4) demonstrated that the following indicators are most correlated with the first root (variate):

- in the group of R&D sector indicators: lnBERD GERD, HRST (for all: negative correlation);
- in the group of IT sector indicators: ITstaff, ITvacant (for both: positive correlation);
- in the group of labor market indicators: only Lcost (positive correlation).

Table 4. Factor loadings and canonical weights of 3 groups of variables with the 1st root

R&D sector			IT & Hi-tech sector			Labor market		
Variable	Factor Loading	Weight	Variable	Factor Loading	Weight	Variable	Factor Loading	Weight
GERD	-0.808	0.181	ITGDP%	0.208	-0.323	Unempl	-0.269	-0.182
lnBERD	-0.942	-0.893	HTExp	0.391	0.275	Lprod	0.003	-0.006
HRST	-0.786	-0.138	ITstaff	0.936	0.842	Lcost	0.917	0.932
JobMob	-0.670	-0.294	ITvacant%	0.794	0.216	Gen_pg	0.286	0.337

However, only lnBERD (R&D sector group), ITstaff (IT & Hi-tech sector group) and Lcost (labor market group) have a high factor loading and weighting factor. The rest of indicators for groups with a low factor load and a small weighting coefficient determine the 2nd, 3rd and 4th canonical variables (roots).

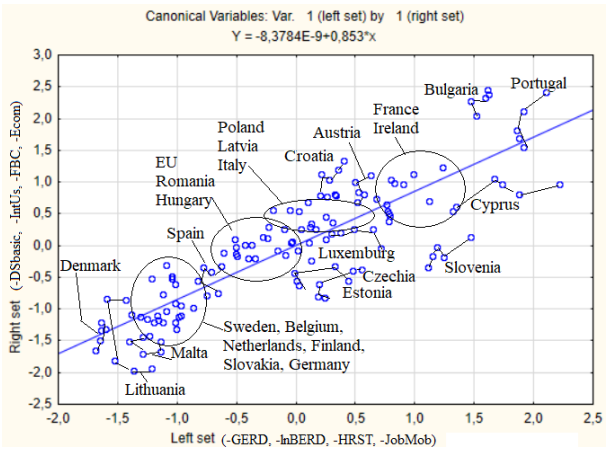
A correlation analysis between three pairs of sectors of indicators made it possible to assess the dynamics of the development of the indicators of the four analyzed sectors, as well as to identify the leading countries and backside ones.

Thus, the combination of indicators of digital and scientific development revealed a negative correlation of both groups of indicators with the first canonical variable, but the canonical correlation between the indicators of the two sectors is positive (Fig. 2a). Thus, the countries that lead in the digital and R&D development are located in the lower left corner (negative values of the canonical variables) (Denmark, Lithuania, Malta) and the backside ones are placed in the upper right corner (positive values of the canonical variables) (Portugal, Bulgaria).

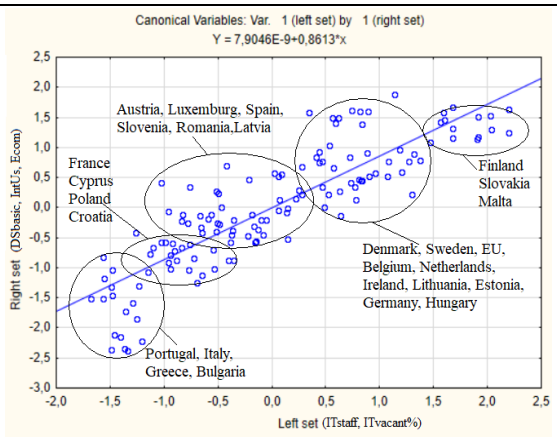
Analyzing the correlations between the indicators of digital development and the IT&Hi-tech sector, a positive correlation of both groups of indicators with the first canonical variable and between the two sectors of indicators was revealed.

The dependence graph of digital IT & Hi-Tech development indicates the greatest density of data, which makes it impossible to build individual development trajectories for individual countries. The leaders among the EU countries were Finland, Slovakia and Malta, the opposite edge was occupied by a group of Eastern and Southern European countries: Portugal, Italy, Bulgaria, and Greece.

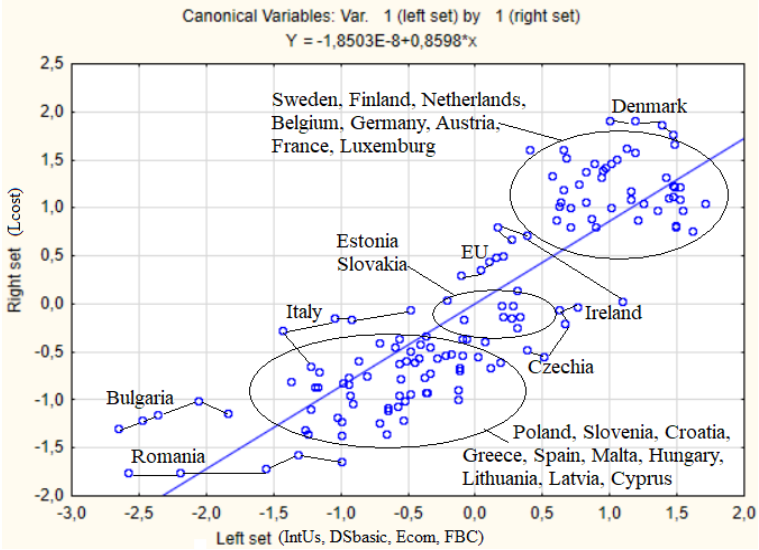
According to the results of CCA (Fig. 2c), the higher level of digital development is associated with an increase in personnel costs (Lcost); so that more qualified personnel with a sufficient level of digital skills require higher compensation. The leader among indicators of digital development and the level of personnel costs is Denmark, at a slight distance from it are 8 countries: Austria, Finland, France, Germany, Belgium, Luxembourg, the Netherlands, Sweden. A separate position is occupied by Italy and Ireland which have a higher wage rate than countries with a similar level of digital development. Portugal, Poland, Greece, Croatia, Bulgaria, and Romania have indicators of both digital development and wages at a level significantly lower than the average European parameters. However, during the analyzed period, Bulgaria and Romania significantly improved their indicators of digital development but leaving the Lcost wage indicator almost unchanged.



a) Digital development and R&D sector

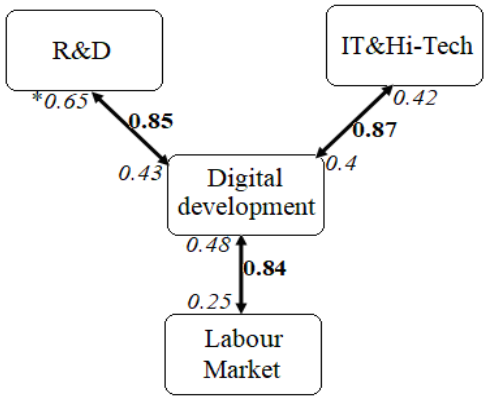


b) Digital development and IT & Hi-tech sector



c) Digital development and Labor market

Figure 2. Scatterplot of canonical correlations for 3 pairs of CCA: digital + R&D (a), Digital + IT & Hi-tech (b), Digital + labor market (c) on the base of 1st root for left and right set



*0.XX - *Variance extracted by the first variate*

**0.XX - Canonical correlation between digital development and respective sector

Figure 3. Summary of canonical correlations and variance extracted

4. Discussion

The final data of the interrelations between digital development indicators and the three analyzed sectors of indicators are presented in Figure 3.

Besides the canonical correlation (which is indicated in the center of each arrow), the indicator of the share of the variation of the variables has significant information, that has explained by the first variate. Thus, the first R&D variate explains 65% of the variation of the four indicators included in the group. Accordingly, the first variate of the IT & Hi-tech sector determines 42% of the variation of the group's indicators, and the first variate of the labor market finds out only 25% of the variation of the indicators. In turn, when analyzed with the indicators of the three analyzed sectors, the first variate of digital development finds out 40-50% of the variation of the input indicators by sector.

In the paper (Gavkalova et al., 2017) authors proved, that the cumulative impact of policy leverages and instruments create conditions for the environment in which the government must take measures in order to ensure effective implementation of its regulatory policy based on the integrated index of socio-economic development. Such approach could be taken into account. Concerning the CCA of investigated indicators, the results allow developing directions of government regulatory policy.

The data in Table 3 determined that among the indicators of digital development, the most significant are the number of Internet users and the level of individuals of digital skills. Therefore, the government digital policy should be aimed at supporting education in the IT field. In order to attract a larger number of users, the focus of government policy should lay on expanding the access network and the quality of Internet services.

The only significant indicator among the indicators of the labor market sector is the level of wages, which is positively correlated with digital development. Therefore, companies need to pay attention when planning the costs of paying staff with new digital skills. Other indicators of the labor market sector have weak connection with digitalization. For instance, the correlation index for the level of unemployment has a value of -0.269, which means that digitization has weak interrelation with unemployment. Unemployment is a complex phenomenon and digitization affects the labor market indirectly.

The results of the calculations (Table 4) did not reveal a stable relationship between digitalization indicators and the level of labor productivity, which may indicate that digitalization is a more socially significant phenomenon.

As for the R&D sector, all indicators are strongly correlated with digitalization indicators, which should be taken into account when developing a government digital strategy. The most important indicator in the R&D group is the indicator of business enterprise expenditure on R&D. This means that increasing funding for digitalization should become a priority for business. Government support of research funding is also important in order to ensure the competitiveness of business and the national economy as a whole. There is experience of Sweden (Statistics Sweden, 2021), which pays significant attention to the R&D sector. In Sweden, important research has strong support through funding programs both public and private initiatives. These are such foundations as Vinnova, Swedish Research

Council, Swedish Agency for Innovation Systems, Formas, Forte, Knut and Alice Wallenberg Foundation and others. Such policy allows Sweden to take a leading position in terms of digital and socio-economic development indicators and at the same time ensure the competitiveness of the national economy at the international level.

5. Conclusions

As a result of the study, the approach to analyzing the interrelations of the digital development indicators and the indicators of IT & Hi-tech, R&D sectors as well as the labor market was developed based on the method of canonical correlation analysis. The results of the research have proved the existence of a stable correlation between indicators of digital development and indicators of three sectors: R&D sector, IT high-tech sectors, as well as labor market. Canonical correlation of indicators of digital development with indicators of each of three sectors exceeds 0.8. Correlation analysis between three pairs of sectors of indicators made it possible to identify the leading countries and propose directions of government digital policy.

The indicators of digital development that mostly correlate with the indicators of each sector were identified. Thus, the indicators of the digital skills level, the share of Internet users and the share of e-commerce in the turnover are involved in the formation of the first variate compared with the indicators of all three analyzed groups. The indicator of the share of users with a fixed broadband FBC connection is involved in two of the three comparisons (with indicators of each sector). However, the two indicators of High-speed Internet coverage (HSIC) and Mobile subscribers (Mobsub) are weakly related to the first variate.

The regional peculiarities of EU-countries were explored based on correlation between investigated indicators in the period of 2016 to 2020. Thus, the countries of Scandinavia region and Northern Europe belong to the group of leading countries when compared with each of the three analyzed sectors, but in each comparison, there are countries joining them. For instance, in the canonical analysis of indicators of digital development and R&D sector, Estonia and Malta joined the leading countries; in the canonical analysis of indicators of digital development and IT & Hi-tech sector, Slovakia and Malta joined the leading countries. Most of the countries of Eastern Europe have indicators correlation for the analyzed groups below the average European level.

The proposed approach enables to conduct effective government digital policy as well as to choose necessary policy instruments on the basis of the current digital development of the country as well as taking into account correlations between other sectors of the economy. The proper use of government regulatory policy instruments determines further effectiveness of the steps taken.

The prospects for further research in this area are the study of factors influencing the government digital policy taking into account internal and external environment as well as hybrid treats. Further research will focus on developing a cognitive model of factors that influence the government digital policy and applying it as a basis for the development of impact scenarios.

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Conflict of interest: none

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Analysis of Bank Accounts Using Multi-Criteria Decision-Making and a Custom Web Application

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Abstract: The topic of multi-criteria decision-making and evaluation of alternatives is currently very popular, and many authors use these methods in various economic areas including banking. The aim of the article is the application of multi-criteria decision-making methods to bank account analysis. The first part will describe the theory of banking and bank accounts, methods of multi-criteria decision-making, and methods for determining the weights of criteria, their principle, and method of application. The bank accounts of those banking entities with the highest balance sheet for the year 2021 will be analyzed. Based on this decision, eleven banking entities were selected. Another goal is the analysis of the evaluation of student bank accounts and regular bank accounts with the help of selected methods of multi-criteria decision-making with the use of our own web application. This will allow the user to choose a bank account that will be optimal given the user's set preferences.

Keywords: bank account; criteria; weights; multi-criteria decision making; evaluation of alternatives

JEL Classification: D81; C69

1. Introduction

The banking industry in Europe is being changed by the emergence of new technologies, new players, and favorable regulatory frameworks such as the European Commission's Payment Service Directive 2, which came into force in 2018 (Omarini, 2022).

Decision-making is a process that a person encounters daily. However, these are usually not very important decisions, which is why most people think instinctively and without thinking. Whatever decision is made in these situations; it can be expected that the choice will not have a significant impact on the individual's future. However, in the case of important decisions, such as a strategic decision of the company, a choice of employment, or for example, a certain investment, it is advisable to think about the consequences of choosing a particular choice and possibly use a certain tool that is suitable for making a decision and choosing the option that is the most advantageous. Choosing the right option is all the more important in cases involving personal finances. Most people care about their finances, they want to take care of them in the right way, protect them and use them appropriately. That's why choosing the optimal bank account seems like an important decision, especially in times of the current economic crisis.

The topic of multi-criteria decision-making and evaluation of variants is currently very popular and many authors use these methods in various economic areas, for example (Kandakoglu et al., 2022) or (Macháč et al., 2021). Especially in banking, multi-criteria decision-making methods are used by (García et al., 2010) and (Doumpos & Zopounidis, 2010).

1.1. Banking Products and Bank Accounts

Banking products are services that banks can offer and usually perform for a fee. These products are usually of an intangible nature, i.e., they are not visible and cannot be stored or patented. They can be connected to each other or mutually conditioned. Banks can use the conditionality of individual products when setting prices for these products, especially if the link is very tight (when using one product, it is more or less automatically required to use another product), when the price of a certain product is very low (or the service is free), with the aim of attracting clients.

The systematization of banking products is not very unambiguous due to their large number and great diversity. Probably the most widespread breakdown of bank products is according to their reflection in the bank's balance sheet. They are therefore divided into active, passive, and neutral banking products. Active banking products are those reflected in the bank's balance sheet assets. For these products, the bank acts as a creditor and receives claims (e.g. when granting a loan) or ownership rights. Passive banking products, on the other hand, are reflected in liabilities. These are mainly products where the bank acquires foreign capital on a loan basis, and a classic passive banking transaction is the receipt of a deposit.

A bank account is a banking product that reflects the relationship between the bank and its clients. The client's bank account can be characterized as an account of the bank's receivables and liabilities resulting from its relations with the client. If the bank is in the role of the debtor, it records its debts and obligations towards a specific client through a bank account.

There are several types of bank accounts based on the purpose of their use. The breakdown of these bank accounts may not be completely uniform. Individual banks can modify or combine these accounts in a certain way, for example, to increase the attractiveness of these banking products for their clients.

When a client decides to purchase a current account with a particular bank, the revenues, and costs that the account will bring to the client play a significant role. In the case of income, this is so-called interest, and the costs of a current account most often include fees associated with the use of account services, such as ATM withdrawals, account statements, or fees for outgoing foreign payments.

The study (Fernandes & Pinto, 2019) states that owing to the intangibility, long-term delivery, and complexity of financial services, also characterized by considerable uncertainty (Ponsignon et al., 2015), cultivating high-quality relationships with customers is of paramount importance (O'Loughlin et al., 2004; Oly Ndubisi, 2007), particularly in an age of increased depersonalization, homogenization, and automation in the industry (Barari & Furrer, 2018; Hedvicakova, 2017; Mačí, 2022).

1.2. Multi-Criteria Decision-Making and Evaluation of Options

Multi-criteria decision-making problems are described by a set of n variants $X = \{x_1, x_2, \dots x_n\}$, which are assessed based on m criteria from the set $K = \{K_1, K_2, \dots K_m\}$. From this information, a multi-criteria decision-making model can be formulated (which, according to the characteristics of the set of variants, is either discrete, when the variants are evaluated according to criteria, or continuous, which has a set of variants expressed by a system of limiting conditions), in which it is additionally necessary to include additional information about subjective preferences decision makers. It follows that other important information is also related to the criteria, such as their weight, importance, or relationship to other criteria.

The variant that would simultaneously achieve the best rating in all criteria is referred to as ideal. However, this variant usually does not exist in the set of variants, and it is necessary to look for an alternative non-dominated variant, for which there is no other variant in the set of variants, which is better evaluated according to at least one criterion, and not worse according to the other criteria, while the selection of these variants usually requires the decision maker's preferred information. The opposite of the ideal variant is the so-called basal variant, and it is the variant that has the lowest evaluation of each criterion from the entire set of variants.

2. Methodology

2.1. Methods for Determining Criteria Weights

Criteria preference can be expressed in several ways. Can be set as

- aspirational levels of criteria (nominal information),
- order of criteria (ordinal information),
- criteria weights (cardinal information),
- or they may not be set at all.

Criteria weights are non-negative real numbers that express the different importance of the selected criteria with respect to the target evaluation of the variants. Most work is done with standardized weights, which applies

$$\sum_{j=1}^{m} v_j = 1. \tag{1}$$

In the issue of multi-criteria decision-making, one can also encounter cases where information about preferences is completely missing in the set of criteria or is given through a preference relation on the set of criteria.

2.2. Fuller's Method

This method of determining the weights of criteria uses a pairwise comparison of criteria, where the number of comparisons in the case of n criteria is equal to the number $\binom{n}{2}$ in the case of using this method, and its principle is based on the comparison of two criteria each time, with the more significant being selected from this pair criterion, and the weights are thus derived from a preference relation on the set of criteria.

It is called Fuller's method because the application of this method uses the so-called Fuller's triangle - it is a preference matrix P that represents the more significant criterion from each possible pair, while only the upper triangle of the matrix is defined, and the rest of the matrix can subsequently be derived. For the element $p_{j,k}$ of this matrix it holds that

$$p_{j,k} = \begin{cases} 1 \text{ if the j-th criterion is more important that k-th criterion,} \\ 0 \text{ in other cases.} \end{cases} \quad (2)$$

The unstandardized weight of the j-th criterion w_j, which determines its significance, is derived from the number of criteria over which this criterion is preferred, and this weight can be calculated according to the formula (Fiala et al., 2008).

$$w_j = \sum_{k=1}^{n} p_{j,k} + 1 \quad (3)$$

where the added one prevents the least significant criterion from having zero weight.

2.3. Saaty's Method

Saaty's method differs from the pairwise comparison method in that, instead of the preference matrix P, an intensity matrix S is entered, the elements of which represent the relative importance of the j-th criterion to the k-th criterion (Fiala et al., 2008). When entering the values of this matrix, a five-point scale of preference intensities is usually used

$$s_{j,k} = \begin{cases} 1 \text{ if the criteria are equally important,} \\ 3 \text{ weak preference of the j} - \text{th criterion over the k} - \text{th criterion,} \\ 5 \text{ strong preference of the j} - \text{th criterion over the k} - \text{th criterion,} \\ 7 \text{ very strong preference of the j} - \text{th criterion over the k} - \text{th criterion,} \\ 9 \text{ absolute preference of the j} - \text{th criterion over the k} - \text{th criterion.} \end{cases} \quad (4)$$

If the j-th criterion is less significant than the k-th, then the value of the element $s_{j,k}$ corresponds to the value

$$s_{j,k} = \frac{1}{s_{k,j}}. \quad (5)$$

2.4. Methods based on minimizing the distance from the ideal variant

The TOPSIS method is based on the principle of the distance of the variant from the ideal and basal variant. For its application, a cardinal evaluation of the variants according to the criteria and determination of the weights of the considered criteria is required.

The application procedure of the TOPSIS method consists of several steps, while first, it is necessary to construct a normalized matrix according to the formula

$$r_{ij} = \frac{y_{ij}}{\sqrt{\sum_{j=1}^{p} y_{ij}^2}}. \quad (6)$$

The columns of the resulting matrix specify vectors of unit length. In the next step, the normalized weighted criterion matrix is calculated by the relation

$$w_{ij} = v_j r_{ij}. \tag{7}$$

Subsequently, the basal variant D and the ideal variant H are determined based on the values of the matrix W, which was compiled in the previous step. Further, the distances of the variants from the ideal variant are calculated using the formula

$$d_i^+ = \sqrt{\sum_{j=1}^{k} (w_{ij} - h_j)^2} \tag{8}$$

and, from the basal variant

$$d_i^- = \sqrt{\sum_{j=1}^{k} (w_{ij} - d_j)^2}. \tag{9}$$

Finally, the relative distance indicators of the variants from the basal variant are calculated

$$c_i = \frac{d_i^-}{d_i^+ + d_i^-}, \tag{10}$$

while the values of these indicators are in the interval ⟨0,1⟩, where the value 0 is taken by the basal variant and the value 1 by the ideal variant (Talašová, 2003).

2.5. Other Used Methods

Other methods used include the ranking method and the scoring method, which are described for example in (Brožová et al., 2003) or (Šubrt, 2011).

3. Analysis and Results

3.1. Data Description

The first step of the analysis itself was obtaining information about bank accounts. It was decided that the bank accounts of those banking entities with the highest balance sheet amount (i.e., the largest amount of managed money) for the year 2021 will be analyzed, to reduce the number of bank products analyzed. Based on this decision, eleven banking entities with the largest balance sheet total for 2021 were selected (see Table 1).

The resulting data sample of bank accounts to be analyzed contains data on 28 bank accounts offered, including both regular and student bank accounts. The selected attributes of these bank accounts are the type of bank account – student or current, internet banking, interest rate p.a., a one-time fee for opening an account, monthly account management fee, ATM withdrawal fee in the Czech Republic, fee for withdrawal from an ATM of another bank

Table 1. Selected banks in 2021

Bank	Balance sheet in bn. CZK	Number of clients	Net profit in bn. CZK	Operating since	Number of ATMs in Czech Republic
ČSOB	1,805.0	4.225 mil.	16.200	1964	837
Česká spořitelna	1,642.0	4.493 mil.	14.200	1825	1,414
Komerční banka	1,244.4	2.251 mil.	12.700	1990	807
UniCredit Bank	693.5	0.850 mil.	6.980	1996	190
Raiffeisenbank	511.0	1.200 mil.	4.690	1993	135
Moneta	340.2	1.400 mil.	3.980	1998	545
Fio banka	215.0	1.162 mil.	2.300	2010	215
Air Bank	151.0	0.986 mil.	1.472	2011	261
Equa bank	73.7	0.519 mil.	0.553	1993	16
Banka Creditas	67.0	0.150 mil.	0.115	1996	0

in the Czech Republic, fee for withdrawing from an ATM abroad, fee for withdrawal from a foreign bank's ATM abroad, fee for balance inquiry via ATM, a fee for a balance inquiry via a foreign bank's ATM, fee for withdrawal at a bank branch, fee for account statement sent electronically, fee for account statement sent by post, fee for sending an information SMS, a fee for a one-time payment via the Internet, fee for one-time payment at the branch, fee for setting up/executing a standing order at a branch, a fee for setting up/executing a standing order via the Internet.

From the list of criteria, it can be seen that criteria were chosen that relate to the possibilities of modern times (for example, the use of Internet banking, the possibility of payment via the Internet), but also in today's not-so-used possibilities of using bank accounts, such as the possibility of payment at a bank branch. The choice of diverse criteria was made due to the possibility of using the bank calculator by different age generations, which have different preferences.

3.2. Results of the Analysis

Bank accounts were analyzed by almost all implemented multi-criteria decision-making methods. The method of basal variants cannot be used for analysis due to incompatible data. An error condition occurs during the calculation, as the data contains zero values, and when substituted into the formula for calculation, division by zero occurs. For that reason, an analysis of bank accounts will be carried out using the weighted sum method, the TOPSIS method, the Lexicographic method, and the ranking method, for all the mentioned models - i.e., the student, adult, and senior models.

Following results are for TOPSIS method. For all implemented methods similar tables were done and evaluated.

4. Discussion

In our work, the results of the following methods were implemented and evaluated: the lexicographic method, the order method, the TOPSIS method, and the weighted sum method.

The Table 2 above shows the results obtained by the TOPSIS method.

Table 2. Results for TOPSIS method, Source: own processing

Bank	Account	Model Adult		Model Student		Model Senior	
		Order	Value	Order	Value	Order	Value
Air Bank	Current account	10	0.79765	10	0.81550	1	0.94197
Banka CREDITAS	Current account	4	0.91868	4	0.94098	8	0.71444
Česká spořitelna	Student account			12	0.79420		
	Standard account	11	0.77536	13	0.78983	4	0.77583
	Plus account	13	0.75741	16	0.76920	5	0.74904
ČSOB	Plus konto			18	0.64426		
	Basic account	17	0.48628	20	0.62520	15	0.60437
Equa bank	Current account	2	0.93893	2	0.95763	3	0.86330
Fio banka	Student account			1	0.96257		
	Personal account	1	0.94138	8	0.89653	2	0.89267
Komerční banka	My account Gold	8	0.85266	9	0.84025	9	0.71002
	Student account			11	0.79603		
	My account Plus	12	0.77076	14	0.78923	10	0.70481
	My account	14	0.56084	17	0.70531	14	0.65638
MONETA Money Bank	Tom account Plus	3	0.92167	3	0.94325	6	0.74541
	Tom account	7	0.86010	7	0.90388	7	0.74504
	Genius Student			22	0.60276		
	Genius Gold	16	0.55831	25	0.42118	17	0.54211
Raiffeisenbank	Exclusive account	15	0.56066	24	0.49731	19	0.45949
	Premium account	9	0.80206	15	0.77719	13	0.68611
	Clever account	5	0.91607	5	0.93855	11	0.70266
	Active account	15	0.90697	6	0.92338	12	0.69206
UniCredit Bank	Start konto	18	0.48151	19	0.63320	16	0.58799
	Account Open	19	0.45204	21	0.60782	18	0.53047
	Account TOP	20	0.36556	23	0.51840	20	0.42144

In contrast to the evaluation of the variants using the order methods and the Lexicographic method, we found that some bank accounts have a relatively different final order. For example, Tom Account Plus, which was determined by the Lexicographic method as an ideal account for students and adults, was evaluated by the TOPSIS method as the third most advantageous bank account, while the current (or student) account from Fio Bank was determined as the most advantageous option.

Like the case of the TOPSIS method, the weighted sum method also evaluated bank accounts from Fio Bank as the optimal option for students and adults, which was mainly contributed to low fees for making payments via the Internet and low withdrawals from ATMs. For seniors, as with the previous method, the Air Bank current account has the highest utility value, mainly due to the low fees for bank operations performed at the branch.

5. Conclusions

The aim of the article was the application of multi-criteria decision-making methods to bank accounts. The lexicographic method, the order method, the TOPSIS method, and the

weighted sum method were implemented, evaluated, and compared on data from 28 bank accounts.

The current (or student) account from Fio Bank was determined as the most advantageous option using TOPSIS method and the weighted sum method. Also, Tom Account Plus, which was determined by the Lexicographic method as an ideal account for students and adults, was evaluated by the TOPSIS method as the third most advantageous bank account, so it is a very good result.

Of course, the results of the analysis depend on the chosen method of determining the weights of the criteria and on the chosen evaluation method. All parameters can be changed in the web application and decision-making tailored to the future client. Considering the current economic development of the Czech Republic, when the inflation rate is around 15 percent, banks will have to actively respond to this development and adapt their offer. Thus, clients will have to constantly monitor developments in the banking market and the economic situation and evaluate how best to manage their financial assets. It is necessary to take into account that the real interest rate is negative for retail accounts.

The challenge in retail banking is not only to attract new customers but to retain them and enhance relationships with existing ones, it is important to know the factors necessary to build solid relationships with customers (Sayil et al., 2019). The role of relationship marketing in establishing long-term relationships and building customer loyalty in the banking industry has been strongly emphasized in the literature (Sayil et al., 2019; van Esterik-Plasmeijer & van Raaij, 2017).

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Calculation of Costs of Mental Bulimia: Vomited Money

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Abstract: Bulimia nervosa is one form of binge eating disorder (BED) and is characterized by repeated and frequent intake of large amounts of food in a short period of time. The aim of this article is to conceptualize "vomited money", which could be resonant in many ways, and the emerging data on this concept can fundamentally add to the economic importance and seriousness of this issue. The methodology of our research is based on the Cost of Illness (COI), which is a descriptive analytical approach focusing on the calculation of the economic costs of the researched disease. The basic approach is to include direct costs - costs incurred for health care and indirect costs resulting from lost earnings, reduced work productivity, or morbidity. For calculation of direct costs data from VZP were used. For calculation of "vomited money" a focused qualitative experiment was performed. Based on our research with 6 respondents in different stages of bulimia, the share of "vomited money" exceeds the expenditures of health insurance funds, so we can say that "vomited money" is a relevant cost and should be considered as part of COI methodology when calculating the costs of mental bulimia.

Keywords: mental bulimia; cost of illness; vomited money

JEL Classification: I10; I11; I13

1. Introduction

Bulimia nervosa is not only a serious psychiatric illness, but according to Tannous et al. (2022) this is an economically burdensome situation. In 2021, eating disorders in Czech Republic reached almost CZK 70 million. This is based on VZP data, with 60% market share the biggest insurer in the country, in which, eating disorders represented CZK 41.6 million (VZP, 2022). And the costs rise in time, compared to 2017, in 2021 the costs are higher by 62% and the number of patients rose from 658 to 1,034. So, this means direct costs at CZK 40,232 (1,676 EUR) annually per person.

According to the European Commission (2019) eating disorders (incl. bulimia) affect around 20 million people in Europe with an estimated costs of EUR 1 trillion per year.

Bulimia nervosa is one form of binge eating disorder (BED) and is characterized by repeated and frequent intake of large amounts of food in a short period of time (roughly two hours). Episodes of overeating can repeat up to two to ten times a day. This state is followed by a combination of activities aimed at reducing weight and getting rid of all the calories taken in.

Starting with vomiting, followed by drastic diets and hunger strikes, excessive exercise, diuretics, and laxatives. Typically, feelings of humiliation, depression and self-condemnation appear after overeating (Abraham et al., 2006; Petr et al., 2014). End of life relapses and connections with other types of PPP and addictions are common (Pokrajac-Bulian et al., 2015; Faleide et al., 2010).

Not only women suffer from bulimia, but there are also known cases of bulimic men (Papežová, 2012; Jenkins et al., 2011). In Czech Republic, roughly one in twenty girls and young women are affected (Anabell, 2018). In the general population, the prevalence varies on average between 2-5% (Hort et al., 2008; Papežová, 2012).

In reality, the prevalence could be double. Every second woman is dissatisfied with her proportions and weight and often tends to stick to various diets, exercises, etc. Up to about 10% then think about vomiting food to get rid of excess kilos (Krch, 2008; Button et al., 2010).

Overall, the disease disrupts the normal course of life, contributing to desocialization, postponement of duties, loss of family and other ties, up to loss of productivity and work ability, i.e., economic inactivity (Winkler, 2014).

The aim of this article is to focus on “visible” and “invisible” costs of mental bulimia using the Cost of Illness approach. The main contribution of this article is of methodological nature to (1) identify new types of costs that are bulimia specific and (2) running a small experiment to check whether these costs are relevant to the Cost of Illness approach. More specifically, in this article we would like to conceptualize “vomited money", which could be resonant in many ways, and the emerging data on this concept can fundamentally add to the economic importance and seriousness of this issue.

2. Methodology

Cost of Illness (COI) is a descriptive analytical approach focusing on the calculation of the economic costs of the researched disease (Jo, 2014). The basic approach is to include direct costs - costs incurred for health care (diagnostic and imaging examinations, costs for drugs, rehabilitation, outpatient treatment, hospital stay, transport to a medical facility, home improvement, diet for the sick, etc.) and indirect costs resulting from lost earnings, reduced work productivity, morbidity, and possible disability of the caregiver.

Some approaches include a third item, namely intangible costs – losses in terms of reduced length and quality of subsequent years of life. All these types of costs are, if possible, quantified in monetary terms. Data can be obtained from insurance companies, from ÚZIS, from employers and direct caregivers from a questionnaire survey (Larg, 2011).

For calculation of direct costs data from VZP will be used (VZP, 2022).

For calculation of “vomited money” a focused qualitative experiment will be chosen as main research approach. The sample for the research investigation are 6 selected respondents, each of them representing one of the stages of mental bulimia and they will be presented individually in their personal case histories based on partially conducted interviews.

All respondents are from center Anabell (Praha, Brno, Ostrava) and all the interviews were conducted 2022. The characteristics of respondents are in Table 1.

Table 1. Characteristics of the respondents by mental bulimia stage and activity profile

Respondent	Stage	Activity profile
1st respondent	onset, duration up to six months after the outbreak	high school student
2nd respondent	bulimia - duration between 1-5 years	university student
3rd respondent	bulimia lasting more than 5 years	working person
4th respondent	a person after several years of relapse	an adult
5th respondent	-bulimic attacks for 1 year, previously anorexic tendencies for 3 years preceding it bulimic stage lasting 4 years	male with combined form of PPP
6th respondent	bulimia lasting 3 years with frequency of attacks 2-3 times per month	n. a.

For gathering data, a semi-structured questionnaire will be used to complete and obtain accurate data, corresponding to the COI method. The questionnaire is focused on many clinical and economical aspects of mental bulimia, for this article, we will be focusing solely on "vomited money".

The relevance of the "vomited money" will be compared to overall direct costs of mental bulimia to evaluate the relevance of this type of costs in COI methodology.

3. Results

The answers from interviews were clustered into 5 groups: (1) dealing with food eaten, (2) change in psychic, (3) financial costs in one month, (4), implication to family life and (5) work and school. Here, in this article, we will focus on dealing with food eaten (qualitative results) and financial costs (quantitative results) to bring evidence of "vomited money".

3.1. Qualitative Results

Regarding to the 6 respondents, here are the main messages, how they are dealing with food eaten. The answers are mixed, and the order of answers does not correspond to the order of respondents in Table 1:

- *"I'm throwing up. When I can't throw up, I can get drunk to the point of nausea so that it comes out. For about two months, I took 50 drops of Guttalax every time I vomited. I took it as insurance. Honestly, it wasn't very pleasant, and after a while I came to the fact that it was useless. And also, as a poor student, I can't afford to stuff money into gluttony and Guttalax."*
- *"I put my fingers in my mouth and start to suffer. It is not possible anymore. Sometimes, in a desperate attempt to vomit, I injure my pharynx and it hurts. Sometimes it catches fire. After a while of trying, it usually gets going. It depends on what I eat. I already know in what order I must eat the food so that it goes out more easily. I'll hurt my hands too. My joints are dry and cracked. Vomiting lasts for 2.5 hours."*
- *"I vomit and take a bottle of laxative every day. At every opportunity.'*
- *"I don't eat anything except low-calorie foods, the so-called "safe food", which gives about 100 kcal per serving. If I eat something more, it's enough to feel full even after fruits and vegetables, mentally I can't stand it. I just pull my hair up into a rubber band and go to the bathroom to throw up."*

- *"I'm throwing from time to time, now I try to hold it in for more days each time, then it's better to vomit. It was a plague every day and it didn't work. I recently tried such a salt cleanse - a person gradually drinks x liters of salty water in a short time. It drives it through and everything that is in the intestines goes. It's a hum, but I can't help it."*
- *"Remorse and panic attacks come first, then vomiting, then self-harm a few times."*

Based on the interviews with 6 respondents we can formulate a strong hypothesis for further research, that vomiting food is a daily routine for people suffering from this disease. This will be relevant in the economic context, that every food that was vomited, needed to be eaten first. And paid.

3.2. Quantitative Results

Financial hardship of bulimia:

- *"When I'm at home, for me at all. I eat what I find in the pantry, in the freezer, my mother makes, my grandmother brings. Although, these are finances of my parents. I never thought about it this way. Terrible. It will be a lot. I don't buy much myself anymore, I didn't get along with money.''*
- *"On average, about a hundred a day + what I eat at my parents' or visits. That's enough too." (approx. 3,000 CZK / month)*
- *"I don't always throw up daily, sometimes several times. Well, it can be around 700-800 CZK per week and that is about half of what I eat. I also put a lot of money into supplements - guttalax, dehydrating pills, etc., which also gives me a decent pocketbook per month, about 600 CZK." (approx. 2,800–3,200 CZK / month)*
- *"I don't eat much, I stick to the low-carb, low-sugar, zero-kcal ones. Well, it also costs something, maybe even more. I estimate the waste of food (money) for 2,500–3,000 CZK per month." (approx. 2,500–3,000 CZK / month)*
- *"It's a lot, really lot. One day I lost five hundred crowns and threw it all up. I went to the store thinking I was going to throw it all away. I have such days almost most of the month. Realistically, it will definitely be over 7,000 per month, and that's just for food." (approx. 7,000 CZK / month)*
- *"We calculated it together once, as far as I remember, it was around 4.5 thousand on average, right? There were also months around 1,000 CZK, but also around 8,000 CZK." (approx. 4,500 / month)*

Now these results show that people suffering from mental bulimia can spend a lot of money that is later being vomited. More precisely, based on these 6 respondents, it can be from 2,500 CZK up to 7,000 CZK per month. When calculating an average from these 6 respondents, we can come to an average of 4,050 CZK per month. So, "vomited money" may represent 48,600 CZK annually.

It is very important to put this cost into context with expenditures of health insurance funds. Based on data from VZP (2022), in 2021 the overall costs on eating disorders (anorexia, bulimia, binge eating) represented 41.6 million CZK with a prevalence of 1,034 patients registered in VZP. This would mean an average cost 40,232 CZK annually. So, the share of "vomited money" (48,600 CZK annually) exceeds the expenditures of health insurance funds

(40,232 CZK annually), so we can say that "vomited money" is a very relevant cost and should be considered as part of COI methodology when calculating the costs of mental bulimia.

4. Discussion

Calculation of economic costs of eating disorders (incl. bulimia) can be complete only when all, direct and indirect costs are incorporated. Under the economic burden of bulimia, we can include the use of resources in the healthcare sector, healthcare costs and social costs (Ágh, 2016).

Most of the research conducted in the field of eating disorders is focused on direct medical costs, which are the easiest to calculate and best proven. The direct health care costs of bulimia are calculated at EUR 3,294 per year (Pohjolainen et al., 2010). Another study talks about EUR 1,762 per year when including different direct healthcare cost items (Grenon et al., 2010). The research of Prof. Crow (2009), focusing on the calculation of direct non-medical costs, speaks of an amount of EUR 4,735 per year. There is great variability in the procedure for calculating individual costs, and therefore also possible room for further investigation. In Czech Republic, the direct healthcare costs paid by health insurance funds are around 1,655 EUR annually.

Our research goes beyond of direct costs and focuses on indirect costs, especially on a new category of costs, so called "vomited money". Based on our research with 6 respondents, we can say, that "vomited money" can be a very significant part of total costs. More specifically, in our research we showed, that "vomited money" (48,600 CZK annually) can be even higher than the expenditures of health insurance funds (40,232 CZK annually). In this context, "vomited money" is an important part of costs should be incorporated into the COI methodology as part of the indirect costs.

The main limitation of this article is the sample size, since we had only 6 respondents. On the other hand, the answers on "vomited money" are quite concentrated and can be on average compared to average expenditures of health insurance funds. Further research will be needed to confirm or hypotheses on "vomited money" on larger scale of patients.

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The Use of Technology in Long-Term Inpatient Care for People with Alzheimer's Disease

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Abstract: Alzheimer's disease is an incurable, neurodegenerative disease. The increasing prevalence of Alzheimer's disease represents a significant challenge in the future. As the number of patients grows, so does the demand for long-term inpatient care. The capacities of long-term inpatient care facilities, however, are already insufficient, and solutions need to be found to provide care to an ever-increasing number of patients. A possible solution is the use of technologies. The aim of this work is to analyze which technologies are in use in long-term inpatient care facilities in the South Bohemian Region and the Vysočina Region in the Czech Republic. A questionnaire survey was conducted in nursing care facilities and nursing care facilities with a special regime. Active use of technologies including patient data digitization, patient transfer technology and brain training tools were found. Only a few respondents employed technologies to monitor patient vital functions as well as track motion and detect falls. A comparison of the regions did not show significant differences in the use of technology. A comparison of facility types revealed the greatest difference was in the more prevalent use of motion tracking and fall detection technologies in nursing care facilities with special regime.

Keywords: Alzheimer's disease; inpatient care; technology

JEL Classification: I10; I11; I19

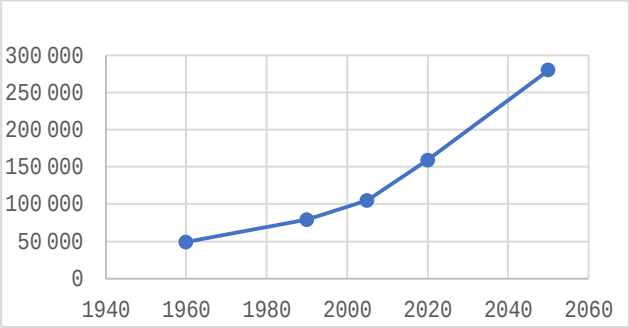
1. Introduction

Alzheimer's disease is a chronic, neurodegenerative disease that is, unfortunately, incurable. Current treatment can only retard the course of the disease. The onset of the disease most often occurs after the age of 65 (Korábečný et al., 2020). In connection with the demographic considerations, the extension of the life of diseased and other influenceable and non-influenceable factors, the prevalence of Alzheimer's disease is increasing. Due to the ever-increasing number of people suffering from Alzheimer´s disease, this disease represents a significant threat for the future (Dawson and Phil, 2018).

According to the Česká alzheimerovská společnost (2022), there are currently approximately 161,000 cases of Alzheimer's disease in the Czech Republic. Alzheimer's disease is a problem not only for the Czech Republic, but for the entire world. Zissimopoulos et al. (2015) predicted that the number of people over 70 suffering from Alzheimer's disease would increase by more than 153% between 2010-2050. Chain (2010) estimated that the number of people suffering from Alzheimer's disease would almost triple by 2050. Mátl et al.

(2016) estimated that the number of people suffering from Alzheimer's disease would more than double between 2020 and 2050. Although the estimates of individual authors differ slightly, the result of all sources is similar - the number of people suffering from Alzheimer's disease will increase. Figure 1 depicts the predicted increase in the number of people suffering from Alzheimer's disease in the Czech Republic.

Figure 1. Development and prediction of the number of persons suffering from Alzheimer´s disease (Česká alzheimerovská společnost, 2021)



Alzheimer's disease is associated with the need for help from other persons in the field of health care, social care, and management of patient's daily activities, this need constantly increases with the progress of the disease. This makes caring for people with Alzheimer's disease very demanding on human resources (Holmerová, 2018). The capacity of long-term inpatient care facilities in the Czech Republic, however, are already insufficient, while the demand for services and the number of diseased significantly exceeds the capacity of the facilities (Novák, 2018).

The possibility of the patient living at home under the care of relatives as informal caregivers is offered. But the role of a caregiver is very physically, mentally, time and financially demanding and not every person is able of this. Some people live alone and do not have a person, who can be an informal caregiver (Holmerová, 2018). The role of informal caregivers also has an impact on the country's economic situation. People who decide to become an informal caregiver often have to leave their profession in favor of caring for a relative. These caregivers become economically inactive and do not perform their jobs. As the prevalence of the disease increases, so does the number of people who leave their profession to care for a relative. The system is losing many workers of various professions because they cannot get inpatient care facility for their relatives. Caring for the relative is limited in time and after the death of the diseased person, the caregiver can return to work. However, dropping out of the work profession causes a loss of qualification. Returning to the work environment is thus difficult for informal caregivers (Geissler et al., 2015).

With the increasing prevalence of the disease, the important question is, how we will be able to take care of all diseased people who will need help. Human resources, and especially qualified human resources, are limited and there may be a situation where, due to the increasing prevalence of Alzheimer's disease, there will be an acute shortage of caregivers. A possible solution is the use of technology. Technology cannot be understood as a complete replacement of workers. Human power is absolutely irreplaceable and will always be needed (Sugihara, 2013).

Technology is a way to provide better, more accurate and faster care (Reedy, 2021). This has a positive effect on the patient and on the burden on the caregivers. Reducing the burden on caregivers while maintaining at least the same level of service quality allows them to provide care to more patients. Acquisition costs are associated with the advent of technology, but their use represents a reduction in labor costs.

In the Czech Republic, the real level of technology usage in long-term inpatient social-health care facilities is currently unknown. This work contributes to mapping the real level of technology use in long-term inpatient care facilities. Thus, the primary research question is: What technologies are currently employed in long-term inpatient care facilities in the South Bohemian Region and the Vysočina Region?

1.1. Types of Technology

The concept of technology is very broad. Unable to find an existing comprehensive framework of usable technologies for people suffering from Alzheimer's disease, one is offered here. Figure 2 describes the concept. The basis is to cover all the needs of patients with Alzheimer's disease. According to the Česká alzheimerovská společnost (2022), symptoms of Alzheimer's disease include memory loss, speech problems, disorientation, poor rational judgment, personality changes, changes in initiative, movement problems. These are progressive and, at present, there are no curative treatments. Patient care needs include assistance with daily activities and mobility, health care, patient safety, social contact, and cognitive training.

As the available technology review publications always only cover part of the needs of people suffering from Alzheimer's disease, more existing technology reviews were used. Miwa et al. (2021) presents a list of technologies to assist movement and daily activities and technologies for social contact. Boulton et al. (2016) deal with technologies for maintaining patient safety using monitoring technologies. An inseparable basis for the use of technology is the digitization of patient data (McQuivey et al. (2020). A total of five groups of technologies were proposed, which cover all the care needs of patients suffering from Alzheimer's disease: patient data digitalization (1), patient transfer (2), monitoring of vital functions (3), motion tracking and fall detection (4) and social activities and brain training (5).

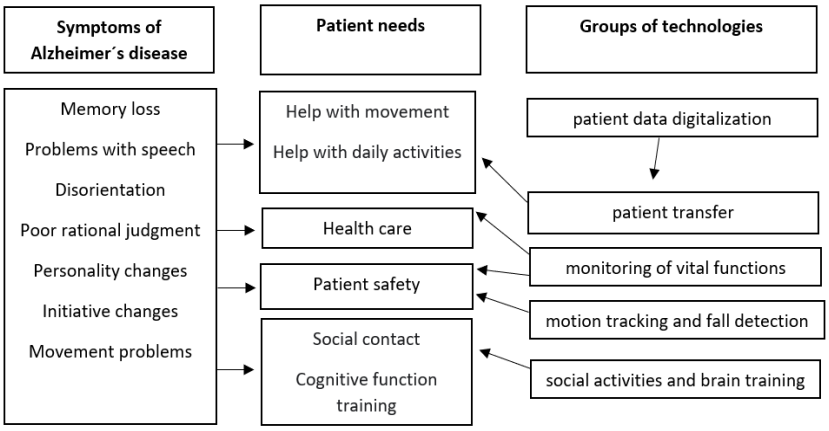


Figure 2. Groups of technologies in the care of people with Alzheimer's disease

An important cornerstone is the digitization of patient data. McQuivey et al. (2020) find in patient data digitization likely facilitates necessary tasks, predicts and warns of dangers, and improves the accuracy of diagnoses and targeted care.

Similar views are published by Priyananadan and Brahm (2016), who perceive digitization as a precursor to future of care that permits early identification of likely problems and complications while providing cost savings and improved equipment performance. The digitization of data represents the basis for future integration of smart devices or artificial intelligence tools.

A basic area where technology can be used is patient transfer. Transfer devices include, for example, electronic beds, electronic lifts, electronic walkers and more. These technologies are not suitable for collecting patient data and then using the information with artificial intelligence, but they are a great help for reduce the burden of staff, reducing falls and their consequences and saving time (Sivashankar et al., 2019).

Results flowing directly from the used technologies can enter the patient's electronic evidence. There are many wristbands, bed pads or other devices that detect basic vital functions such as heart rate, blood pressure, respiration rates, temperature, blood sugar level and others. Mesquita et al. (2016) mention that the use of these tools produces benefits for both patients and staff. Breasail et al. (2021) describes motion detectors, GPS locators, fall detection and other devices that store and evaluate client movement data as also a great help. Groups of technologies for vital function monitoring and movement monitoring consist of part of data collection and part of the use of artificial intelligence tools for evaluation and prediction of possible dangers.

The last major area of use of modern technologies is the social part of care. You can use computers and tablets here not only to communicate with relatives or medical specialists, but also to train your memory and cognitive functions. There are a huge number of applications to support the cognitive functions of the brain (Miwa et al., 2021). Social robots, of which there are many types, are also an important helper. Social robots resemble a human or a pet. An example of a therapeutic robot that is used in long-term inpatient care is the PARO robot. Paro (2022) states that this robot is suitable for therapy in places where it is not possible to perform therapy with a live pet.

2. Methodology

Quantitative research was conducted on long-term inpatient care facilities in the Vysočina region and the South Bohemian region. The interviewed subjects were nursing care facilities and nursing care facilities with a special regime. According to § 49-50 (Act no. 108/2006 Coll.), only nursing care facilities with a special regime are intended for people suffering from Alzheimer's disease, while nursing care facilities are not. However, the reality is different and people with Alzheimer´s disease are also live in nursing care facilities (Hanzalová et al. 2020). For that reason, both types of facilities are included in the research sample.

The research sample and the number of respondents is described in Tables 1 and 2 below of the Vysočina region and the South Bohemian region. Information about the facilities was

obtained from the database of the services of the Czech Alzheimer's Society. Data were collected using a questionnaire protocol guiding collection via personal interviews or telephone calls. The survey was conducted during the period August 2022 – October 2022.

Table 1. Characteristics of the respondents in South Bohemian region

Type of facility	Total number of facilities	Number of respondents	Research coverage
Nursing care facility	25	8	32%
Nursing care facility with a special regime	20	4	20%
Both types of facilities together	45	12	27%

Table 2. Characteristics of the respondents in Vysočina region

Type of facility	Total number of facilities	Number of respondents	Research coverage
Nursing care facility	26	9	35%
Nursing care facility with a special regime	19	5	26%
Both types of facilities together	45	14	31%

The questionnaire consisted of five basic questions. Each question explored about one group of technologies. The specific groups were: patient data digitalization (1), patient transfer (2), monitoring of vital functions (3), motion tracking and fall detection (4) and social activities and brain training (5). If the respondents answered affirmatively, they also indicated the specific type of technology in use.

We subsequently looked for specific types of technologies in publicly available documents (websites and annual reports). For a representative sample of respondents, it was necessary to obtain at least 10% response rate (Pecáková, 2018). This minimum limit was observed in both regions. In the South Bohemian region, 27% of facilities were connected, in the Vysočina region, 31% of facilities were connected.

3. Results

The survey research conducted focused on the use of technology in nursing care facilities and in nursing care facilities with a special regime in the South Bohemian Region and the Vysočina Region. Many technologies are known that can be used in the care of people suffering from Alzheimer´s disease. But no one knows what the actual level of technology use in devices is, and this research will focus on that.

3.1. The Level of Technology Use in Long-Term Inpatient Care

Respondents answered the questions whether they use technologies from five basic groups: 1. patient data digitalization, 2. patient transfer, 3. monitoring of vital functions, 4. motion tracking and fall detection and 5. social activities and brain training. Table 3 summarizes the results of the South Bohemian Region. Table 4 summarizes the results of the Vysočina region. These tables represent the number of devices from all respondents that use a given group of technologies. The first column shows the total number of respondents. The following columns indicate how many respondents confirmed the use of technologies from

the given groups. The analyzed values are divided for nursing care facilities and nursing care facilities with a special regime.

In the South Bohemian region (Table 3), a total of 12 respondents took part in the research – 8 nursing care facilities and 4 nursing care facilities with a special regime. All respondents stated that they use technologies from the patient data digitalization group and patient transfer group. In the monitoring of vital functions group, 2 respondents confirmed the use. 3 respondents use technologies for motion tracking and fall detection, and 9 respondents confirmed the use of technologies for social activities and brain training.

Table 3. The use of technology in South Bohemian region

Type of facility	Total respondents	Patient data digitalization	Patient transfer	Monitoring of vital functions	Motion tracking, fall detection	Social activities, brain training
Nursing care facility	8	8	8	1	1	6
Nursing care facility with a special regime	4	4	4	1	2	3
Both types of facilities together	12	12	12	2	3	9

In the Vysočina region (Table 4), a total of 14 respondents took part in the research – 9 nursing care facilities and 5 nursing care facilities with a special regime. All respondents stated that they use technologies from the patient data digitalization group and patient transfer group. In the monitoring of vital functions group, 1 respondent confirmed the use. 3 respondents use technologies for motion tracking and fall detection, and 9 respondents confirmed the use of technologies for social activities and brain training.

Table 4. The use of technology in Vysočina region

Type of facility	Total respondents	Patient data digitalization	Patient transfer	Monitoring of vital functions	Motion tracking, fall detection	Social activities, brain training
Nursing care facility	9	9	9	1	0	7
Nursing care facility with a special regime	5	5	5	0	3	2
Both types of facilities together	14	14	14	1	3	9

3.2. Types of Technology

Subsequently, the research focused on the identification of specific devices. Table 5 and 6 summarizes which specific types of technologies are used in the facilities. These tables contain a list of specific devices used and the frequency of their use. The frequency of use is expressed in the number of facilities and as a percentage of the total number of respondents. Table 5 presents the use of technology in nursing care facilities. Table 6 represents the use of devices in nursing care facilities with a special regime. Each table presents the results for the South Bohemian region, the Vysočina region and both regions together.

Table 5 contains data on the use of technology in nursing care facilities. A total of 17 nursing care facilities participated in the questionnaire, of which 8 facilities from the South

Bohemian region and 9 facilities from the Vysočina region. All respondents used technologies for patient data digitalization. In the patient transfer technology group, all respondents used electronic beds and electronic lifts. Electronic walkers used 6 respondents. Monitoring bracelets were used by 2 respondents – 1 device from the South Bohemian region and 1 device from the Vysočina region. No respondent used GPS locators. Only 1 respondent used camera systems. A total of 12 respondents used cognitive training games on a shared computer and only 1 respondent used technology to provide personalized cognitive training. For most technologies, there is no difference in the frequency of use between regions. The most significant difference is the use of camera systems, which uses one device from the South Bohemian region and no device from the Vysočina region. In the case of personalized cognitive training, the technology uses one device from the Vysočina region and no device from the South Bohemian region.

Table 5. The use of technology in nursing care facilities

Group of technologies	Type of device	Respondents who use the device (South Bohemia)	Respondents who use the device (Vysočina)	Respondents who use the device (South Bohemia + Vysočina)
Patient data digitalization	-	8 (100%)	9 (100%)	17 (100%)
Patient transfer	Electronic beds	8 (100%)	9 (100%)	17 (100%)
	Electronic lifts	8 (100%)	9 (100%)	17 (100%)
	Electronic walkers	3 (38%)	3 (33%)	6 (35%)
Monitoring of vital functions	Monitoring bracelets	1 (13%)	1 (11.1%)	2 (12%)
Motion tracking, fall detection	GPS locators	0 (0%)	0 (0%)	0 (0%)
	Camera system	1 (13%)	0 (0%)	1 (6%)
Social activities, brain training	Cognitive training games on a shared computer	6 (75%)	6 (67%)	12 (71%)
	Personalized cognitive training	0 (0%)	1 (11%)	1 (6%)

Table 6 contains data on the use of technology in nursing care facilities with a special regime. A total of 9 nursing care facilities with a special regime participated in the questionnaire, of which 4 facilities from the South Bohemian region and 5 facilities from the Vysočina region. All respondents used technologies for patient data digitalization. In the patient transfer technology group, all respondents used electronic beds and electronic lifts. Electronic walkers used 3 respondents. Monitoring bracelets were used by 1 respondent. One respondent used GPS locators. Camera systems were used by 4 respondents. 3 respondents used cognitive training games on a shared computer and only 1 respondent used technology to provide personalized cognitive training.

If we compare the results in table 6 for each region, many groups of technologies have the same frequency of use. Compared to the Vysočina region, the South Bohemian region has a higher proportion of use of monitoring bracelets and cognitive training games on a shared computer. The Vysočina region has a higher share of the use of electronic walkers and GPS locators compared to the South Bohemian region.

Table 6. The use of technology in nursing care facilities with a special regime

Group of technologies	Type of device	Respondents who use the device (South Bohemia)	Respondents who use the device (Vysočina)	Respondents who use the device (South Bohemia + Vysočina)
Patient data digitalization	-	4 (100%)	5 (100%)	9 (100%)
Patient transfer	Electronic beds	4 (100%)	5 (100%)	9 (100%)
	Electronic lifts	4 (100%)	5 (100%)	9 (100%)
	Electronic walkers	1 (25%)	2 (40%)	3 (33%)
Monitoring of vital functions	Monitoring bracelets	1 (25%)	0 (0%)	1 (11%)
Motion tracking, fall detection	GPS locators	0 (0%)	1 (20%)	1 (11%)
	Camera system	2 (50%)	2 (40%)	4 (45%)
Social activities, brain training	Cognitive training games on a shared computer	2 (50%)	1 (20%)	3 (33.3%)
	Personalized cognitive training	1 (25%)	1 (20%)	2 (22%)

Table 7 presents a comparison of the frequency of use of specific devices in nursing care facilities and in nursing care facilities with a special regime. Respondents are counted for both regions together. The values are expressed as a percentage of the total number of respondents. The table shows that there are no differences in the frequency of use in the areas of patient data digitization, patient transfer and monitoring vital function. The difference is noticeable in the motion tracking and fall detection group. No nursing care facility used GPS locators and only 6% used camera systems. In the case of nursing care facilities with a special regime, GPS locators were used by 11% of respondents and camera systems by 45% of respondents. In the social activities and brain training group, nursing care facilities used cognitive training games on shared computers more than nursing care facilities with a special regime, but in the case of personalized cognitive training, nursing care facilities used technology less than nursing care facilities with a special regime.

Table 7. The use of technologies in nursing care facilities and nursing care facilities with a special regime

Group of technologies	Type of device	Nursing care facilities	Nursing care facilities with a special regime
Patient data digitalization	-	100%	100%
Patient transfer	Electronic beds	100%	100%
	Electronic lifts	100%	100%
	Electronic walkers	35%	33%
Monitoring of vital functions	Monitoring bracelets	12%	11%
Motion tracking, fall detection	GPS locators	0%	11%
	Camera system	6%	45%
Social activities, brain training	Cognitive training games on a shared computer	71%	33.3%
	Personalized cognitive training	6%	22%

4. Discussion

Technologies represent an important role for the possible increase of the capacities of long-term inpatient care facilities in the care of people suffering from Alzheimer's disease. The capacities of nursing care facilities and nursing care facilities with a special regime are already insufficient, and with the increasing prevalence of Alzheimer's disease, the problem is expanding even further. There is a lack of mapping of the level of technology use in the Czech Republic. The aim of the research was mapping the real level of technology use in long-term inpatient care facilities for people suffering from Alzheimer´s disease in the South Bohemian region and Vysočina region.

The results show that all facilities had patient data digitization and used technology for patient transfer. Data digitization and digitalization are a necessary first step in the eventual use of artificial intelligence tools. In the patient transfer technology group, electronic beds, electronic lifts and electronic walkers are used. There is no possible connection with the use of artificial intelligence tools, but these technologies enable faster care, prevention of falls and their consequences, greater comfort for patients and a reduction in the burden on caregivers.

A lower level of technology use was recorded for the monitoring of vital functions and motion tracking group. Only 3 respondents use bracelets for monitoring of vital functions. In the motion tracking and fall detection group, although 6 respondents confirmed the use of technology, 5 of them subsequently described that they only use camera systems. Only one device used location-specific chips.

The last analyzed group consisted of technologies for social activities and brain training. No device used technology for social activities, such as social robots. 18 respondents confirmed the use of programs for cognitive training. Of these, 15 facilities provided a cognitive training program on a shared computer. Only 3 facilities used the possibility of personalized cognitive functions training according to the health status of a specific patient.

For most technologies, there was no difference in the frequency of use between regions. For nursing care facilities, the most significant difference was the use of camera systems, which uses only one device from the South Bohemian region. The technology for personalized training used only one respondent from the Vysočina region. For nursing care facilities with a special regime, the South Bohemian region had a higher proportion of use of monitoring bracelets and cognitive training games on a shared computer. The Vysočina region had a higher share of the use of electronic walkers and GPS locators.

When comparing the use of technologies in nursing care facilities and in nursing care facilities with a special regime there were no differences in the frequency of use in the areas of patient data digitization, patient transfer and monitoring vital function. The difference was noticeable in the motion tracking and fall detection group, which were mostly used by nursing care facilities with a special mode. In the social activities and brain training group, nursing care facilities used cognitive training games on shared computers more and the case of personalized cognitive training less than nursing care facilities with a special regime.

5. Conclusion

There is a trend of increasing prevalence of Alzheimer's disease. As the number of people with Alzheimer's dementia increases, so do the demands for care. Care in the form of informal caregivers is not suitable for everyone and is also a challenge for the whole country. Informal caregivers become economically inactive due to caring for the diseased relatives. However, long-term inpatient facilities already have insufficient capacity and there is a need to increase preparedness for future increases in demand, related to the growing number of people suffering from Alzheimer's disease. However, human resources and especially qualified human resources are limited. This problem can be mitigated by using technology.

An analysis of the use of technology in long-term inpatient care facilities in the South Bohemian and Vysočina regions was carried out. The use of technology proved to be satisfactory (100% of respondents used the technology) only for some groups of technologies. The results show that all facilities in the South Bohemian region and the Vysočina region actively use technologies from the groups of data digitization and patient transfer. Much of the facilities used technologies for cognitive training, although these were only basic capabilities of cognitive games. Only a few respondents use the technologies for monitoring vital functions and for detecting movement and falling was recorded. A comparison of the regions did not show significant differences in the use of technology. A comparison of device types showed the greatest difference in the use of the motion tracking and fall detection technologies, where there was a higher rate of use in nursing care facilities with a special regime.

The research was conducted in only 2 regions of the Czech Republic. For a comprehensive view of the issue, it will be necessary to carry out comprehensive research that will cover the entire territory of the Czech Republic.

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Conflict of interest: none.

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Sustainability of the Public Debt of Czech Republic and the Risks of its Development

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Abstract: The article focuses on the evaluation of the sustainability of the public debt of the Czech Republic based on its development since 1995 and a comparison with other countries of the Visegrad Group, Slovakia, Hungary, and Poland. Using a forecast based on an econometric model in the Gretl software, the development of the public debt until 2024 is outlined. The rate of growth of the Czech public debt has been growing for a long time, but there is still a relatively large reserve for the convergence criteria of the European Union. However, if the development of the share of public debt in the gross domestic product were to increase in the long term, it would indicate that the Czech Republic lives in higher standards than the economy allows. At the same time, the structure of the Czech public debt can be considered satisfactory, as the majority of the debt is made up of domestic residents.

Keywords: public debt; Czech Republic; forecast; comparison; Visegrad Group

JEL Classification: C13; H68

1. Introduction

Different economic theories look at public debt from different perspectives. The classical theory, whose supporter was, for example, Adam Smith, speaks of the principle of a balanced budget. Keynes held the view that slow economic growth is due to insufficient demand, which prevents the economy from reaching its potential, and which must be revived from public budgets even at the cost of deepening the deficit. However, the second part of his theory explains that during periods when the economy is prosperous, it is necessary to reduce these deficits. The neoclassical theory is built on the foundations of the so-called lifelong income, which came up with the renowned economists Modigliani and Friedman, winners of the Nobel Prize in Economics, and which, according to them, is more important for consumption than disposable income. An individual's income may change negligibly or fundamentally during his life, but consumption remains almost constant. Monetarists were convinced that it was necessary to limit state interventions in the economy to the necessary minimum, since the final effect hinders the growth of the economy and increases unemployment. The view of the theory of the intergenerational distribution of expenditure shocks and the tax burden, which advocates a deficit in public finances if it is caused by large-scale investments in the public sector that are indirect or difficult to identify in terms of returns, is highly debatable. The essence of the definition of the theory is the financing of investments through deficit management across generations, as it is assumed that future generations will also benefit from

these investments (Peková, 2005). On the basis of the mentioned variants of opinion, it is clear that there is no ideal solution for the sustainability of the public debt. Debt is primarily a function of economic conditions reflecting both the need to borrow and the capacity of states to repay debt. However, political factors such as culture, partisan competition, and electoral cycles also affect debt (Clingermayer & Wood, 1995). Expansionary fiscal policies that increase the level of debt may reduce long-run growth, and thus partly (or fully) negate the positive effects of the fiscal stimulus. (Panizza & Presbitero, 2013).

The methodology for measuring public debt in the European Union is governed by the standardized method of Eurostat ESA 2010 (CNB), which replaced the previous method ESA 95. In the Czech Republic, the Czech Statistical Office is responsible for processing this methodology. In parallel with the ESA methodology, the International Monetary Fund's GFS 2001 methodology is also used in the Czech Republic, which is based on the foundations of the now outdated GFS 1986 methodology (Ministry of Finance of the Czech Republic, 2012).

Quantification of public debt is usually in the form of gross public debt, which is a collective designation for all obligations that the public sector has to domestic and foreign entities. Public indebtedness can also be stated in the form of net public debt, which represents the gross public debt reduced by public sector claims to other entities. Gross public debt is subsequently reported as a share of the debt quota, where the following formula describes this relationship:

$$Debt\ quota\ share = \frac{gross\ public\ debt}{GDP} \quad (1)$$

A prime example of the difference between gross and net debt is the Scandinavian countries; although, the share of public state debt to GDP is almost 50%, the share of net public debt is in negative numbers, which implies that the states have an active balance (Nečadová, 2012).

The sustainability of public finances is the ability of the governments of individual countries to maintain their current spending, tax and other policies in the long term without jeopardizing solvency or defaulting on obligations in the future.

2. Methodology

The aim of the presented article is to analyze the sustainability of the public debt of the Czech Republic based on its development since 1995 and a comparison with the countries of the Visegrad Group (V4). Using the forecast of the ARIMA model in the Gretl software, which is based on the modeling of stationary series, the development of the public debt until 2024 is outlined. The processed secondary data is drawn from the sources of the CNB, Eurostat, the Ministry of Finance of the Czech Republic and the Czech Statistical Office.

Based on the analysis, the current risks of social development will be identified and the future development of the public debt of the Czech Republic will be evaluated.

The development of public debt in all monitored V4 countries shows growth from 2020 and therefore the long-term sustainability of public finances is very low. The situation is worst in Hungary and Slovakia, which have already exceeded the share of public debt to GDP of 60%, which exceeds the sanction zone of the so-called debt brake.

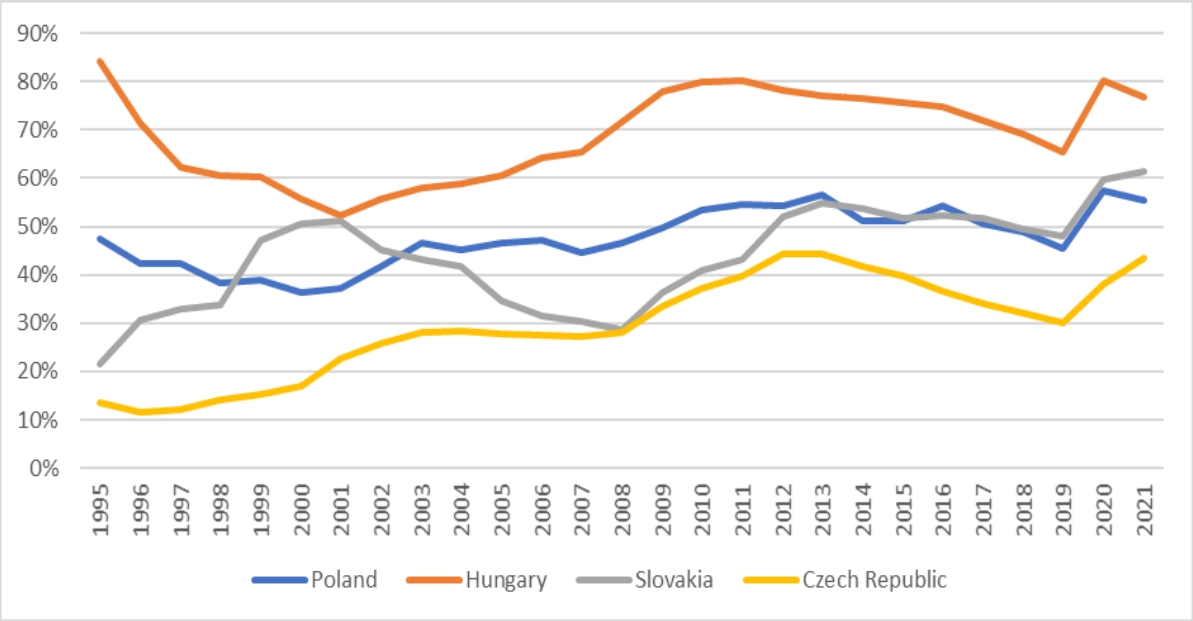

Figure 1. Development of public debt of V4 countries (share of GDP) in the years 1995-2021. Own work based on EUROSTAT, STATISTA (2021)

According to development forecasts, the Czech Republic will exceed this limit in two to three years. The forecast for the next few years is very problematic, as the risks acting on its development show a rocket rise, starting with the coronavirus pandemic from 2020, through the current state of war in Ukraine and the associated charitable expenses for aid to the attacked territory of Ukraine and social benefits to immigrants from the war zone in Czech Republic.

In the same way, the expenses to support the armament of the Ukrainian army and the effects of sanctions on the import of petroleum substances from Russia, which lead to a dizzying increase in the price of fuel and its subsequent projection into the entire economic development of the state, significantly influence the risks of its development.

The forecasting of the current situation is only indicative according to the mentioned significant risks, and the ARIMA forecasting model used will make it possible to show the dispersion interval of future development.

The principle of the ARIMA model is the appropriate differentiation and transformation of the original time series into a stationary series, which can be achieved, for example, by nonlinear transformation using the Box-Cox transformation or by power transformations. When differentiating, in most cases a maximum differentiation order of d = 2 is sufficient, but often a difference of the first order is sufficient.

The difference conversion process plots the following relationship:

$$\Delta y_t = y_t - y_{t-1} \tag{2}$$

The mission of ARIMA models is to describe processes in which level changes occur and these changes have a non-systematic random character, as is common for most time series in practice. These models stochastically model trends as well as random fluctuations.

The mathematical notation of the forecast of the ARIMA model then looks as follows:

$$y_t = \varepsilon_t + \sum_{i=1}^{q} \theta_i \, \varepsilon_t - i \tag{3}$$

where y_t symbolizes the original series and ε_t denotes the so-called white noise process, where the mean value is independent of time.

3. Results

The development of public debt in the compared V4 countries manifested itself differently until 2000, after 2000, when displaying the share of GDP, it has already shown an increasing trend in the vast majority (Figure 1). Hungary has the highest share (up to 80%), the Czech Republic has had a share of around 40% in recent years. When compared with EU countries, the Czech Republic is in a very good sixth place. However, according to the Czech Fiscal Council, the forecast for the years 2022-23 is increasing in the Czech Republic. After 2023, the share of GDP in the Czech Republic could exceed 50%.

In the Czech Republic, as well as in the EU countries, public debt in nominal value has been growing significantly since 2020. From the point of view of the debt structure, however, there is a slight improvement, with the share of foreign debt falling to the current 7% since 2018. Likewise, the share of debt among non-residents is decreasing, which fell from the original 42% in 2019 to the current 26.5%. The situation is caused by the fact that the vast majority of newly issued debts were purchased by Czech entities.

The analysis of the possible future development of the public debt and the risks related to its sustainability is of fundamental importance for all EU countries. The recent negative development of the economy has made it difficult for some countries to access the market due to the debt crisis.

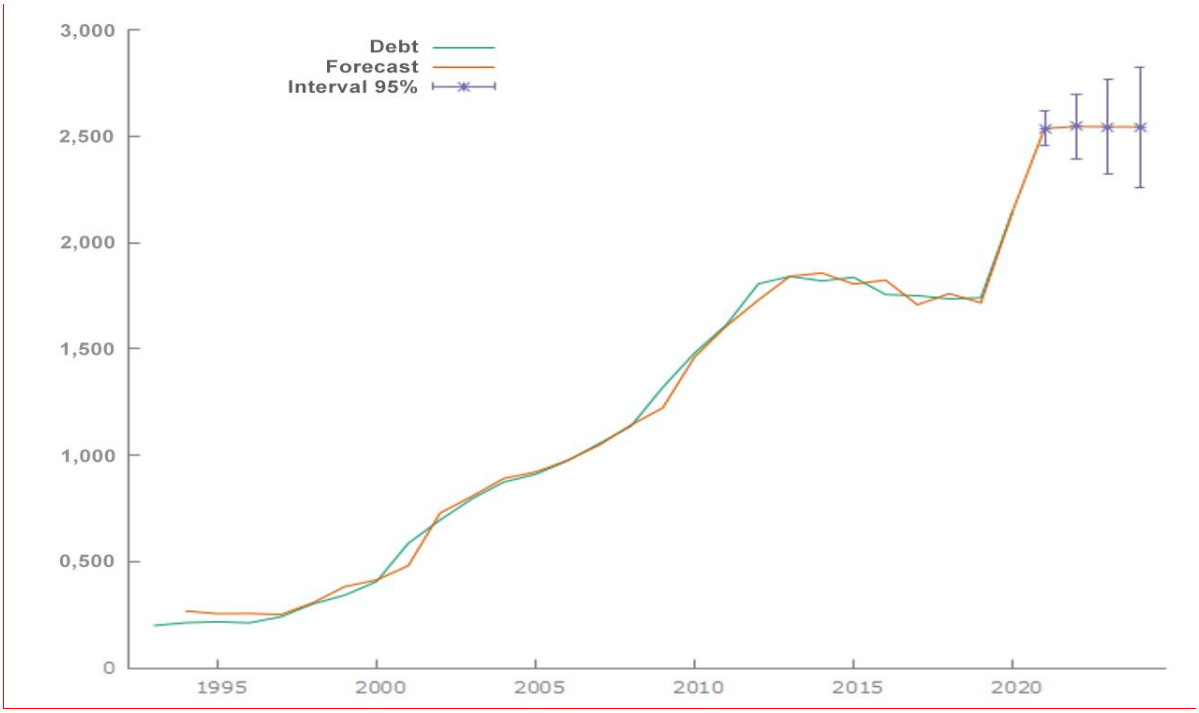

Figure 2. Forecasted values of public debt in millions of CZK until 2024. Own work according to Gretl software (ARIMA model)

When assessing fiscal sustainability, attention must be paid to the current and future level of public debt. Countries with high debt-to-GDP ratios are very vulnerable to economic downturns.

According to forecast modeling carried out using the Gretl software (Figure 2), the value of the public debt for the year 2024 is CZK 2,543.4 billion (in the range of CZK 2,260.8 – 2,825.9 billion). However, this forecast is rather indicative, as the constancy of internal and external conditions cannot currently be guaranteed. Within this framework, even the three-year horizon is quite imprecise.

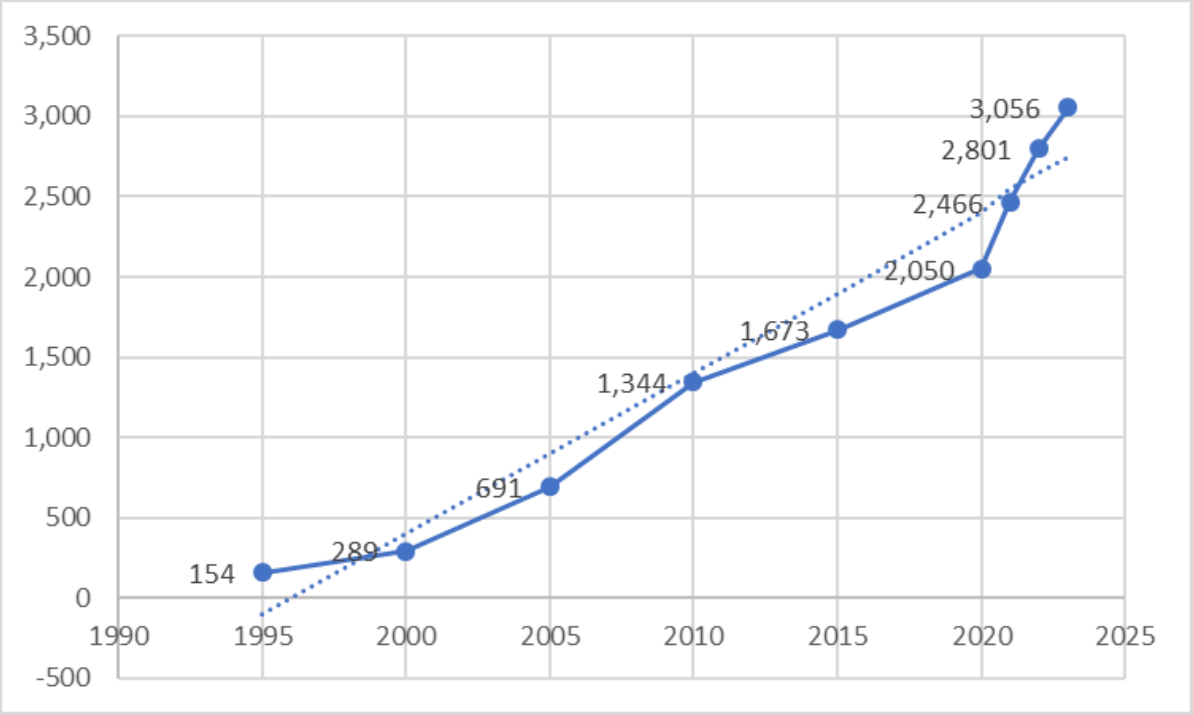

Figure 3. Forecast of the national debt of the Czech Republic until 2024

The forecasted values are also confirmed by the forecast of the Office of the National Budget Council (Figure 3), where the public debt in 2024 will exceed the value of CZK 3,000 billion.

When assessing the medium- and long-term sustainability of public finances, it is important to monitor several different factors. The so-called equation of debt dynamics is thus most often used to assess sustainability:

The key factor for debt dynamics is the so-called debt trap coefficient, i.e. the ratio of the implicit interest rate and the GDP growth rate. If the public budget balance is balanced and the GDP growth rate is higher than the implicit interest rate in the long term, one can speak of a situation of stable debt dynamics. On the contrary, in the case of long-term higher interest rates compared to GDP growth rates, we can talk about a situation that is unsustainable in the long term and the economy is headed for a so-called debt trap. A key parameter in the development of public debt is the balance of public budgets, which is closely linked to the growth of public debt. The tightness of this dependence is primarily represented by the item stock-flow adjustment (hereinafter referred to as SFA) in the equation of debt dynamics. SFA expresses the size of the difference between the deficit of public budgets and the change in

public debt. The operation of the SFA can be divided into three basic categories. The main factor of SFA is the net acquisition of financial assets, which, however, do not have a direct impact on public debt. However, there will be a knock-on effect if the government uses the proceeds from the sale to repay the public debt. Another factor is debt adjustments, among which it is possible to include, for example, valuation effects or exchange rate movements. And the third category contains statistical discrepancies connected mainly with irregularities and updating of monitored data (Czech Fiscal Council, 2022).

Table 1. Stock-flow adjustment (% of GDP) in V4 countries. Own work according to The Czech Fiscal Council

Year	Poland	Hungary	Slovakia	Czech Republic
2017	-1.6	0.7	0.3	1.4
2018	1.1	1.7	-0.1	0.6
2019	-0.3	0.4	-0.4	0.4
2020	5.5	7.2	4.7	1.2

Negative SFA values indicate a lower amount of government debt than its deficit. Although the Czech Republic has shown a positive value in recent years, in 2020 it was significantly lower than in the compared V4 countries.

Other indicators of the sustainability of public finances include indicators S0, S1 and S2 established by the European Commission. This set of indicators is used as part of EU countries' budgetary plans under the Stability and Growth Pact. The short-term fiscal problem is analyzed by the S0 indicator for early warning of risks during the year. The medium-term indicator S1 is generally defined as the fiscal effort required to achieve a set debt-to-GDP ratio. Specifically, the European Commission for the S1 indicator works with a medium-term period (15 years) and with a debt threshold of 60% of GDP. According to this indicator, the Czech Republic shows a sustainable state of public finances in the next few years.

The S2 indicator is a basic element of the analysis of the long-term sustainability of public finances at the EU level. For the assessment of the S2 indicator, the European Commission works with an unlimited horizon and thus expresses the fiscal effort that is necessary for the discounted income and expenditure to be equal and thus to stabilize the indebtedness. The main drivers of long-term fiscal sustainability include the costs associated with an aging population (public spending on pensions) and spending on health and long-term care. In 2020, the Czech Republic ranked fourth worst among EU countries in an international comparison, behind Luxembourg, Slovakia and Romania (Czech Fiscal Council, 2022). The question of the connection of state expenditures with the aging of the population must be addressed now.

4. Discussion

In the vast majority of developed economies, public budgets suffer from long-term recurring deficits and growing public debt (Pospisil, 2016). Higher levels of public debt are associated with lower levels of fiscal sustainability (Aizenman et al., 2013; Fournier & Fall, 2017). In this context, the political consequences of high public debt are also discussed (Blanchard, 2019). It is pointed out that financial market participants usually allocate

sovereign risk by evaluating several sources of sovereign debt risk. According to Attinasi (2009), the main determinants that influence bond spreads of a given country are, for example: default risk, liquidity risk, overall degree of international risk aversion. Various research studies usually try to explain the risk premium of government bonds using the explanatory variables of public debt to GDP ratio and government budget deficit ratio, real GDP growth and inflation rate (Costantini et al., 2014; Rafiq, 2015; Stamatopoulos et al., 2017). Other studies include other variables such as demographic factors, pension obligations or labor productivity growth rates (Afonso et al., 2015; Haugh et al., 2009; Ichiue & Shimizu, 2015).

Baldacci and Kumar (2010) find that significant fiscal deficits and public debts exert considerable upward pressure on sovereign bond spreads of advanced economies, especially in the medium term. Higher inflation means faster nominal GDP growth, which has the effect of reducing the public debt/nominal GDP ratio (Poghosyan, 2014). Understanding the relationship between risk premia and government indebtedness is important because higher risk premia are likely one of the channels through which higher government indebtedness negatively affects economic growth (Reinhart & Rogoff, 2010; Gómez-Puig & Sosvilla-Rivero, 2017). Research by Reinhart et al. (2012) and an analysis of advanced economies found that there is a negative relationship between public debt and long-term growth across countries, i.e. that the excess of public debt slows down the year-on-year rate of economic growth. The mission of the European Central Bank (ECB) is to maintain currency stability and not to act as a lender of last resort for the countries of the monetary union. This is a very important factor for defining the role of public debt on economic growth (Snieška & Burksaitiene, 2018).

It was stated in the article that the value of the public debt itself is not the only essential information. As confirmed by Lagoa et al. (2022) when assessing the sustainability of a given country's public finances, not only the current ratio of public debt to GDP, but also where this ratio is headed, must be considered.

5. Conclusions

Based on the analysis carried out, it can be concluded that the rate of growth of Czech public debt has been increasing for a long time, however, there is still a relatively large gap to the limit of the EU convergence criterion. However, if the development of the share of public debt to GDP were to increase in the following years, it would indicate that the Czech Republic lives in higher standards than the economy allows. At the same time, the structure of the Czech public debt can be considered satisfactory, as the majority of the debt is held by domestic residents, and over 91% of the total public debt is denominated in the Czech crown, which means that the CNB has a powerful tool in the form of at least partial management of this debt, its monetary politics. Consequently, the balance of preferences of political parties does not benefit the Czech Republic on the debt issue, which leads to the impossibility of a long-term conceptualization of public debt management, when populist expenditures are very often carried out in a relatively undisciplined manner, given the nature of the state of public finances, before elections, which only deepens indebtedness.

There are several ways to solve public debt, from monetization of debt to privatization of state assets, to reforms of pension systems and linking the retirement age to the average

life expectancy in society. Considering that in the domestic environment over 90% of public indebtedness is made up of state debt, which has been dealing with deficit management for a long time, it is possible to consider a budgetary solution, where it is necessary to stabilize the state debt and the interest arising from it with the help of government instruments (structural component). This could make the GDP growth rate outpace the public debt growth rate and thus become less problematic. The Czech Republic has a reserve against the convergence criteria and should manage its finances in such a way as to maintain this reserve as long as possible.

Towards the future, it will be very difficult to estimate the development of public debt, because it will depend on several circumstances that can hardly be influenced. In particular, the subsequent development of the global epidemic of the disease Covid-19, and quite undoubtedly also how long the military conflict in Ukraine will last, and the related help of the Czech government to its citizens and Ukraine itself. Likewise, extreme price increases or even fuel shortages associated with sanctions against Russia. All these critical factors negatively affect the possible sustainability of the development of public debt not only in the Czech Republic, but throughout Europe.

In principle, public debt is not a huge problem, but only if that it is possible to underpin it with an efficient economy. Its role within public debt is also influenced by its structure, especially that which distinguishes between domestic and foreign creditors. Currently, the debt structure of the Czech Republic is in a sustainable state for the following period of two to three years. From 2020 on the basis of the mentioned risks, the public debt is skyrocketing, not only in the Czech Republic, and due to the current problems of global economic development, it is not possible to significantly reduce it. It is necessary to proceed very cautiously not only at the level of individual states, but also to deepen mutual unity, cooperation and solidarity between the V4 states and the entire European Union, with an emphasis on the development and maintenance of the common market.

Conflict of interest: none.

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Using the Survival Analysis to Predict a Company's Creditworthiness

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Abstract: The boom in intra-group financing provoked a reaction from the OECD which requires the assessment of intra-group loans according to the principles of transfer pricing within the scope of activities aimed at limiting tax avoidance. The use of the group rating of MNEs is not unambiguous, for which reason the use of other methods of assessing a borrower's creditworthiness, such as the use of scoring models, comes into consideration. The transfer of these models from other countries for application in the Czech Republic is debatable, which is why we consider the use of survival analysis methods for assessing a borrower's creditworthiness, i.e. for the assessment of a company's future ability to repay a loan provided and the interest related to it, in this paper. The possibility of using this approach was tested against the example of enterprises in one branch (NACE CZ 25). Enterprises with long-term negative equity were considered enterprises unable to repay a loan. We estimated a model with a high level of predictive power for the occurrence of financial distress risk using an extended Cox model with time varying covariates.

Keywords: transfer pricing of a financial transaction; creditworthiness assessment; financial ratio; survival analysis methods; extended Cox model

JEL Classification: G38; C41; H25

1. Credit Risk Assessment of Associated Enterprises

The provision of loans for the financing of corporate activities is shifting from bank financing to intra-group financing for large multinational companies. Multinational enterprises (MNEs) focus on the elimination of external indebtedness and more efficient use of funds within the holding company as part of their treasury management. The centralisation of free funds in a single account (master) makes it possible not only to achieve better appreciation of free funds, but also to reduce external indebtedness which is associated with significant savings on interest costs for the entire holding. They often use cash pooling, financial guarantees and, first and foremost, intra-group loans for this purpose. The efficient management of multinational enterprises can help optimise the cost of capital and support their value (and share price).

The OECD is responding to this trend as part of its activities aimed at limiting profit shifting to countries with lower taxation (base erosion and profit shifting – BEPS) – see Deloitte (2021). Transfer pricing guidance on financial transactions, which requires an assessment of a loan provided according to the principles of transfer pricing, was issued in

2020 (OECD, 2020). This means that it will be necessary to consider whether a loan has been made under conditions that would have applied between independent enterprises, and that the same commercial considerations such as creditworthiness, credit risk and economic circumstances are relevant. The given credit assessment will include understanding the business itself as well as the purpose of the loan, how it is to be structured and the source of its repayment, which may include analysis of the borrower's cashflow forecasts and the strength of the borrower's balance sheet (OECD, 2020, paragraph 10.54). Companies are not prepared for these steps and do not have an evidence base that would allow them to create their own models for the assessment of a borrower's creditworthiness.

The basic question when providing intra-group financing is assessment of whether it is a loan or a hidden form of increase in equity (Brychta et al., 2021). If the business cannot prove that this involves a credit relationship, then the costs of the credit (interest and other expenses) are non-tax-deductible costs. This assessment is based both on the economic nature of the financial transaction (its purpose, maturity date, the right to recover the principal and interest, etc. are stipulated) and on assessment of the capital adequacy of the recipient of the loan, i.e. that the recipient is not over-indebted (and no independent company would, therefore, grant it a loan). Therefore, the arm's length principle is that before pricing the loan (interest rate), it must first be demonstrated that the company is not over-indebted and the level of its credit risk must be determined.

The ratings provided by independent credit rating agencies (CRAs) are a widely used and recommended credit risk assessment tool. In view of the time-consuming nature and financial demands of this process, however, the services of CRAs are generally used by MNEs to evaluate the holding as a whole (the MNE group), and are used only minimally to evaluate subsidiaries. Although the fact that a subsidiary is part of a group of multinational enterprises affects its credit rating, the same rating assessment as the assessment of the parent company cannot be applied to all subsidiary enterprises (Solilová et al., 2022). The following table presents a recommended adaptation of the rating of subsidiaries based on the rating of the parent company.

In view of the complexity of the rating determination procedure, the intention is to assess the default risk of an entity in a simplified manner. This leads to the creation of models assessing the risk of default, referred to as bankruptcy models. The principle of the construction

Table 1. Rating recommendation for a subsidiary in an MNE group (Fossati, 2020)

Category of subsidiary	Features	Rating
Core	Integral to the group's current identity and future strategy.	Group rating
Highly strategic	Almost integral to the group's current identity and future strategy.	One notch lower than group rating
Strategically important	Less integral to the group than "highly strategic" group members. The rest of the group is likely to provide support in most foreseeable circumstances. However, some factors raise doubts about the extent of group support.	Up to three notches above the stand-alone rating
Moderately strategic	Not important enough to warrant support from the rest of the group in most foreseeable circumstances. Nevertheless, there is potential for some support from the group.	One notch above the stand-alone rating
Non-strategic	No strategic importance to the group.	Stand-alone rating

of these models is the search for differences between the financial indicators of enterprises that are financially healthy and prosperous and those that are suffering from financial difficulties. These are known as scoring models and represent aggregated indices for evaluating the financial situation of an enterprise. The future development of an enterprise is estimated (in simplified form: prosperity, grey zone, risk of bankruptcy) by comparing it with the score values of other enterprises used to derive the model. Given that the value of these indicators depends on the given sector (taking on different values in different branches of enterprise) and also changes over time as a result of external conditions (first and foremost inflation, the prices of sources of financing, different levels of taxation in individual countries), their transferability from other countries for use in the Czech Republic is problematic. At the very least, they need to be updated with regards to external conditions.

The existing types of models differ mainly in the data they evaluate (accounting vs. market data) and the method in which they were derived. Historically, the following approaches have primarily been developed:

- Beaver's profile analysis, which is a univariate comparison of data on financially healthy enterprises and enterprises that have gone bankrupt. The greatest importance was attributed to the ratio of cash flow (profit after tax + depreciation) to total debts – see Beaver (1996).
- Altman-type models (Altman's model, IN05, Taffler's model). These models are based on multidimensional methods of assessing company risk. They most often combine around five financial ratios. In the case of the Altman model, the output is a Z-score value which is compared to a stipulated cut-off value. It must be added that the Z-score does not have any constrained domain – see Altman (1968).
- Zmijewski-type models. These models again combine a number of ratios calculated from a company's financial statements, though the output of the model takes the form of the probability of bankruptcy (within an interval of 0 to 1) – see Zmijewski (1984) or more generally Slavíček and Kuběnka (2016).
- Merton-type models. Unlike the preceding types of model, these are not based on comparison of the past data of healthy and bankrupt businesses. They are based on the application of the Black-Scholes option pricing model and derive the probability of bankruptcy based on the volatility of the stock value – see Merton (1974).

The first two models can be used to calculate a score that can take on almost any value (the value of the score is not limited in any way). The numbers can vary significantly, for which reason the average for the group may be distorted. This also has an impact on the estimated rating grade and the anticipated risk margin. In the second type of model the output takes the form of a probability, which is a number normalised within an interval from 0 to 1, meaning that the possibility of a result in the form of an outlier is extremely limited.

In this paper, we consider the question as to whether it is possible to use survival analysis methods for the purposes of assessing the debt capacity of a loan recipient and its credit risk. We begin from the assumption that a company that is over-indebted over the long term and that does not generate resources for its further development is not creditworthy, for which reason indebtedness ratios (primarily the debt-to-equity ratio and interest coverage ratio),

indicators measuring the company's ability to generate resources to pay its liabilities (return on assets, operating cashflow to debt, earnings before interest, taxes, depreciation and amortisation to debt), assets turnover, net working capital ratios, and the age and size of the enterprise will be used to assess a borrower's creditworthiness. This is a highly topical issue due to high level of corporate indebtedness. While corporate debt (the debt securities, loans and financial derivatives and employee stock options of non-financial corporations) represented 100% of EU GDP in 2010 (or €11 trillion), it increased to 111% of EU GDP (or €14.9 trillion) in 2020 (see EU, 2022).

2. Methodology

Data was retrieved from the Orbis Academic database. The study focused on a rather small sample in line with our goal. The data covers the ten-year period from 2009 to 2019. The dataset consists of accounting data on 906 companies. These are manufacturing firms belonging to the C.25 NACE classification "Manufacture of fabricated metal products, except machinery and equipment". During the analysed period, 378 of these companies were identified as "zombies", i.e. companies that had reported negative equity in three consecutive years (Blažková and Dvouletý (2022), for example, have labelled this type of firm "zombies").

The dataset was divided into a training and testing sample with a 75% to 25% data partition regarding company identification for out-of-sample predictive discrimination. The training sample consists, therefore, of 680 companies with 4,470 observations and the testing sample consists of 226 companies with 1,354 observations.

2.1. Research Method

Survival analysis methods have recently come to the forefront of interest for researchers in economic and financial fields. One of the most widely used of these methods is the semiparametric Cox proportional hazards model. Its general form is as follows (Kleinbaum & Klein, 2012):

$$h(t, X) = h_0(t) exp(\sum_{i=1}^{p} \beta_i X_i) \quad (1)$$

where $h(t, X)$ is the subject specific hazard at time *t,* which is the hazard related to an individual with a given specification of a set of predictors denoted by X, $h_0(t)$ is the baseline hazard function that changes over time *t,* and $exp(\sum_{i=1}^{p} \beta_i X_i)$ represents the relative hazard as a vector of *p* time invariant covariates, for which reason this part of the expression lacks the time element. This time-independent specification of the Cox model has been applied in previous studies with a similar research focus (e.g. Gemar et al., 2019; Karas, 2022; Kristanti et al., 2019), although we believe that the time variability of financial indicators also plays a role in predicting financial distress. We have therefore used an extended Cox model with time-varying covariates, which has enabled the use of annual financial ratios as predictors of an event – financial distress. The extension of the Cox model that respects both the time-independent and time-varying covariates can be written as (Ledwon & Jäger, 2020):

$$h(t, X) = h_0(t)exp(\sum_{i=1}^{p_1} \beta_i X_i + \sum_{j=1}^{p_2} \delta_j X_j(t)) \quad (2)$$

where $h(t, X)$ is hazard at the time t related to an individual with a given specification of a set of predictors denoted by the X, $h_0(t)$ is the baseline hazard function that changes over time t, β_i and δ_j represents coefficient for p_1 time invariant and p_2 time dependent covariates.

The statistical significance of covariates was evaluated using the Wald test with the null hypothesis that the covariate coefficient equals zero. The assumption of the proportionality of hazard was verified by Schoenfeld residuals with the null hypothesis of respecting the assumption about proportionality (Kleinbaum & Klein, 2012).

2.2. Variables

The variables employed in the survival analysis are presented in Table 2 along with the respective descriptive statistics and the expected sign of regression coefficients. The financial ratios and the expected sign for the survival analysis were based on the previous empirical

Table 2. Descriptive statistics of variables used for the full sample of 906 companies.

Variable	Description	Exp. Sign	n	mean	sd	median	min	max
AGE	Initial Age (in years) of a Company (in 2011)	(-)	5,824	13.54	6.06	14.00	3.00	61.00
EVENT	Becoming a Zombie (1) or not (0)		5,824	0.06	0.25	0.00	0.00	1.00
EBIT	Earnings Before Interest and Tax*	(-)	5,824	9.86	35.40	0.37	-31.81	322.66
EBITDA	Earnings Before Interest, Tax, Amortisation and Depreciation*	(-)	5,824	15.75	48.87	0.78	-16.67	428.38
TA	Total Assets*	(-)	5,824	120.70	341.02	12.44	0.01	2,876.62
S	Sales*	(-)	5,824	149.71	409.63	14.29	0.00	3,653.88
ROA	EBIT to Total Assets	(-)	5,824	0.04	0.29	0.04	-2.37	0.86
ROS	EBIT to Sales	(-)	5,824	-3.03	28.32	0.05	-339.40	4.77
INTRS	Interests Paid	(+)	5,824	0.60	2.03	0.01	0.00	17.61
S/TA	Sales / Total Assets	(+)	5,824	1.46	1.33	1.25	0.00	8.41
NWC/TA	Net Working Capital / Total Assets	(-)	5,824	0.11	1.37	0.28	-15.61	1.00
CA/CL	Current Assets / Current Liabilities	(-)	5,824	3.91	7.52	1.66	0.00	60.70
St/TA	Stocks / Total Assets	(+)	5,824	0.14	0.17	0.07	0.00	0.88
IC	EBIT / Interests Paid	(-)	5,824	17.80	60.98	0.00	-56.58	509.39
OCF/S	Operating Cashflow / Sales	(-)	5,824	-2.44	24.71	0.09	-295.85	11.48
OCF/CL	Operating Cashflow / (Current Liabilities + Interests Paid)	(-)	5,824	0.68	4.55	0.26	-27.53	43.54
TL/TA	Total Liabilities / Total Assets	(+)	5,824	0.74	1.80	0.46	0.00	19.97

Note: Variables marked with an asterisk (*) are reported in mil. CZK, abbreviations used: Exp. Sign = expected sign of coefficient; n = number of observations; sd = standard deviation.

research (e.g. Altman et al., 2010; Chava & Jarrow, 2004; Gupta et al., 2018; Karas et al., 2021; Kramoliš & Dobeš, 2020; Ledwon & Jäger, 2020; Shumway, 2001). The financial variables earnings, sales and assets are considered proxies for the size of a company. A third reporting of negative equity in a row was considered the occurrence of an event. The survival analysis was applied on the follow-up period from 2011 to 2019, since the two preceding years served for the identification of the financial distress of firms in later years.

The preliminary exploratory analysis showed the presence of extreme outlier values for most of the variables, for which reason all variables were Winsorised at the 0.5 or 99.5 percentile level. The threshold for Winsorising was set at such a low level to prevent the bias of regression results caused by extreme outliers on one hand, while retaining the outliers that are believed to be characteristics of firms in financial distress on the other hand.

Correlation was checked by Pearson's correlation coefficient; the respective results are depicted in Figure 1. The correlation analysis revealed strong positive correlation between earnings, assets and sales, as well as between ROS and the cashflow to sales ratio. Strong negative correlation was identified between the TL/TA ratio and the net working capital to assets ratio.

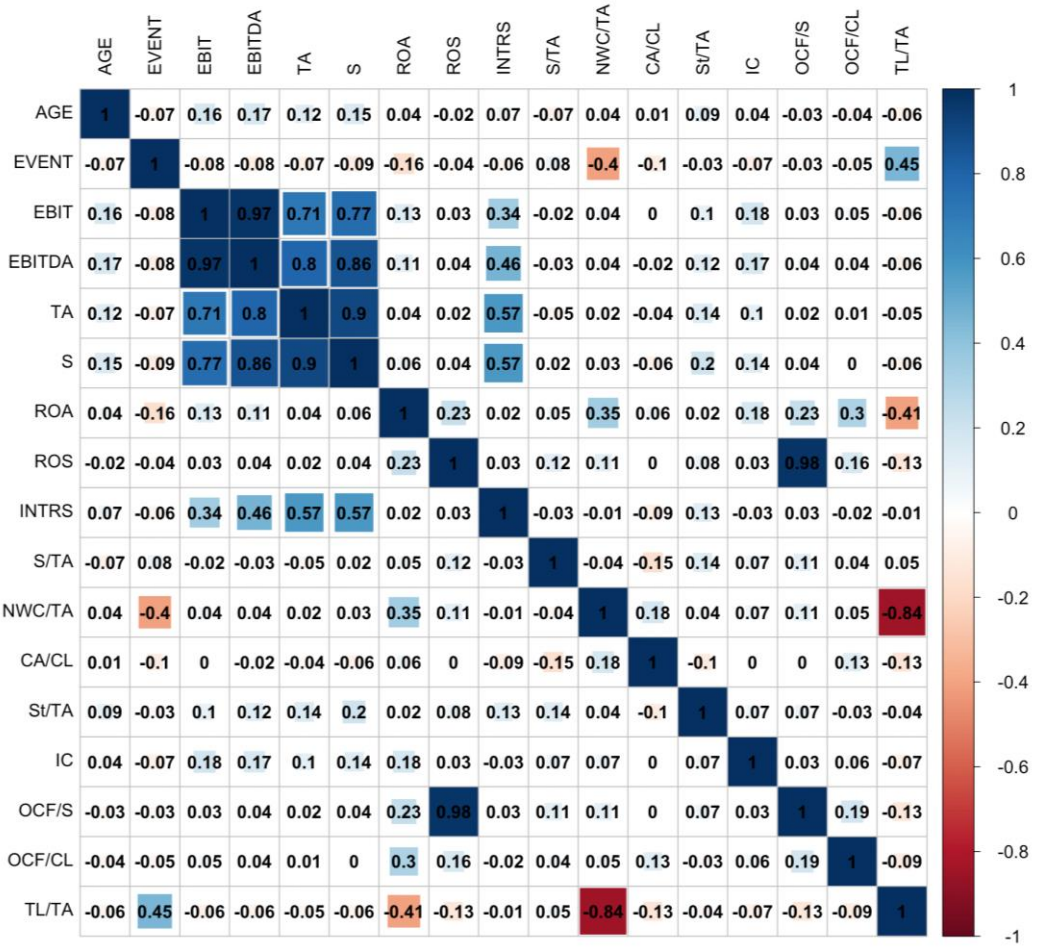

Figure 1. Correlation plot including correlation coefficients.

Four variables were excluded from further analysis, namely EBIT, EBITDA, sales, and NWC/TA, to prevent multicollinearity problems.

3. Results

The model was estimated using a stepwise procedure based on Bayesian information criterion (BIC). Table 3 shows the results of several steps of model fitting. The results suggest exclusion of five variables (ROA, ROE, S/TA, OCF/CL and OCF/S) which do not significantly contribute to the model. The p-value for Schoenfeld residuals for the entire model (not for individual covariates) is reported in the table as GLOBAL. Values above a significance level of 0.05 indicate that the assumption of proportionality holds true. For interpretational reasons, the respective coefficients (β, δ) are reported in its exponents (exp(coef)).

Table 3. Results of the extended Cox model for four steps of model fitting

	COX1		COX2		COX3		COX4	
Var	exp(coef)	se(coef)	exp(coef)	se(coef)	exp(coef)	se(coef)	exp(coef)	se(coef)
TL/TA	1.149***	0.010	1.151***	0.011	1.148***	0.010	1.157***	0.011
TA	0.990***	0.002	0.990***	0.002	0.990***	0.002	0.99***	0.002
CA/CL	0.875***	0.035	0.874***	0.036	0.875***	0.035	0.873***	0.036
IC	0.987***	0.004	0.986***	0.004	0.987***	0.004	0.987***	0.004
St/TA	2.114*	0.314	2.127*	0.314	2.116*	0.314	2.066*	0.316
AGE	0.979*	0.011	0.978*	0.011	0.979	0.011	0.979*	0.011
ROA			1.059	0.110				
ROE			1.000	0.000				
S/TA							1.045	0.037
OCF/CL					0.995	0.010		
OCF/S							1.002	0.002
GLOBAL (sch.resid.)		p=0.164		p=0.156		p=0.189		p=0.0406
BIC	3,073.76		3,084.65		3,079.09		3,081.88	

Significance codes: *significant at the 5% level, **significant at the 1% level, ***significant at the 0.1% level

The final estimated model is considered the COX1 model and its results are depicted in Figure 2. The signs of all coefficients are in line with expectations. Variables with a positive effect on the risk of financial distress are the ratio total liabilities to total assets (TL/TA) and the ratio stock to total assets (St/TA). A unit change in TL/TA results in 1.15-fold increase of hazard. Similarly, a unit change in St/TA results in a 2.11-fold increase in the risk of financial distress.
Variables having a negative effect on hazard, i.e. decreasing the risk of financial distress, are total assets (TA), interest coverage (IC) as a ratio of EBIT to interest expenses, the ratio current assets to current liabilities (CA/CL) and the initial age of the company (AGE). The results suggest a 2% decrease in the risk of financial distress with every additional year in the initial age of a company. In other words, the younger the company is, the higher the risk of financial distress. Every additional million of total asset accounting value also reduces the risk of financial distress by one percent. Although a risk reduction of one unit change seems negligible, considering the total assets variable as a measure of company size and regarding its range in the sample, it outlines a significant difference in the risk of financial distress between, for example, small and large companies in favour of the latter. Finally, one unit change in the financial ratios CA/CL and IC results in a 13% and 1% reduction in the risk of financial distress, respectively.

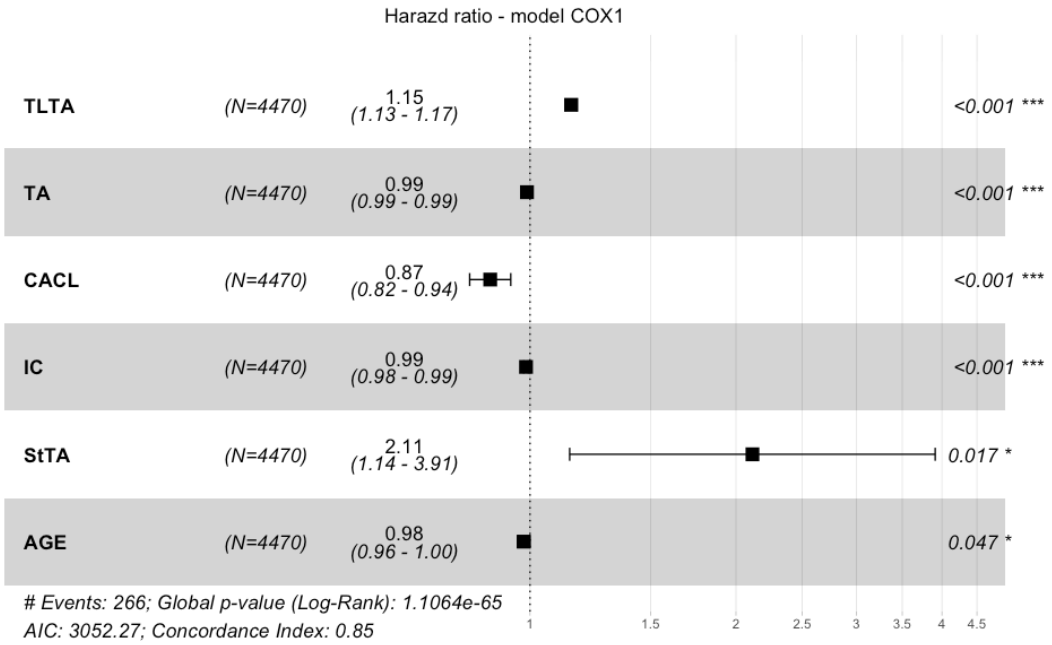

Figure 2. Forest plot for the estimated COX1 model.

The predictive performance of the model was evaluated by the area under the ROC (receiver operating characteristic) curve using the inverse probability of censoring weighting estimates of the time-dependent AUC as suggested by Suresh et al. (2022). The AUC is a scale-invariant measure, with 1 indicating perfect discrimination and 0.5 indicating chance-like accuracy. Out-of-sample validation was performed on a testing sample of 25% of the companies in the collected dataset. The results are depicted in Figure 3 for the whole follow-up period with the results of the AUC (in %) for the first year of the follow-up period.

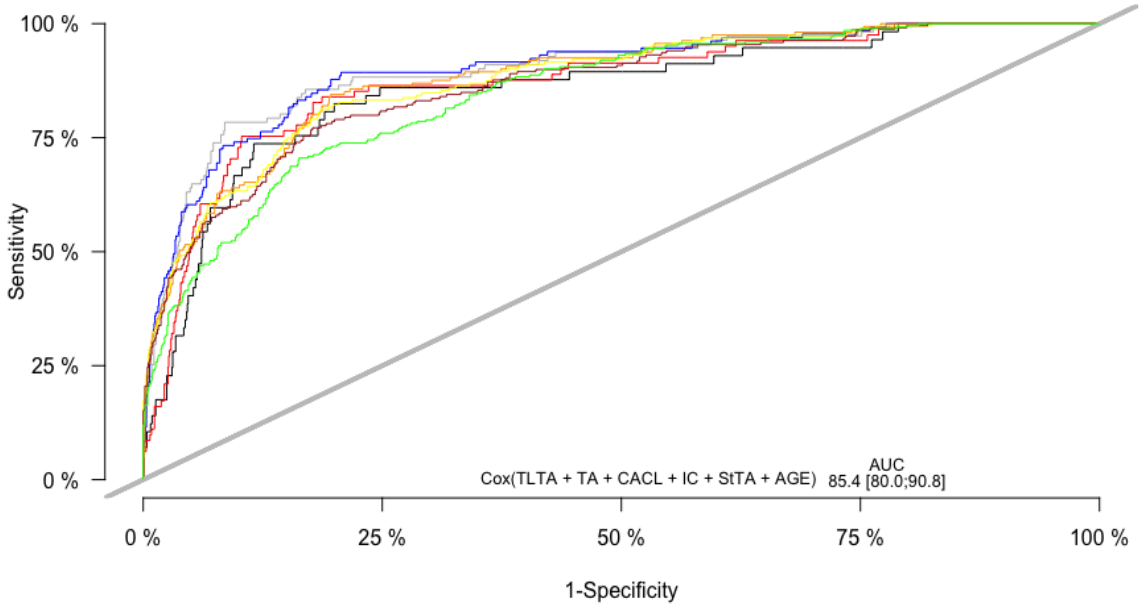

Figure 3. The ROC curve and time-dependent AUC for every year of follow-up (black t=1, red t=2, grey t=3, blue t=4, orange t=5, yellow t=6, brown t=7, green t=8).

The lowest value of the AUC was 0.846 in the eighth year, the highest value was 0.899 for both the third and fourth year of the follow-up period. This suggests, therefore, a relatively high level of predictive discrimination of the model.

4. Discussion

The high level of predictive discrimination of the model entitles us to conclude that the use of an extended Cox model with time-varying covariates is a suitable tool for predicting financial distress when using annual financial ratios as predictors. The model predicts the probability with which a company will face financial distress in the following year. The model predicts the probability with which a company will fall into financial distress in the following period. This makes this type of model suitable for the prediction of creditworthiness. It is surprising that the predictors used did not include the indicator debt-equity ratio, which is used by the financial authorities as a criterion for assessing a financial transaction between connected persons to adjudge whether it is a loan or a hidden increase in equity. Similarly, it is also surprising that neither of the indicators EBITDA and OCF/CL (operating cashflow to current liabilities and interests paid), which are considered indicators of a company's ability to pay its liabilities, were included among the predictors. In further research, it will be necessary to devote attention to testing the predictive ability of other indicators and their economic justification.

The selected approach is original in that it does not only consider companies that have officially gone bankrupt, but also companies that are over-indebted over the long term to which no independent company would provide a loan. The data does not relate merely to companies forming a holding, as we preferred to analyse companies in the same branch of enterprise. Its originality also lies in the methodology we used for the assessment of credit risk. The limitations of the study are twofold – the sample analysed was limited to the field of metal manufacturing and covered a short period, the beginning of which was, in addition, also affected by the economic crisis. However, the sample served well for the goal of the paper to be achieved. The results provide a basis to be built on in further research.

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Basically Realizing Modernization of "Agriculture, Rural and Farmers" in Western China: Definition, Evaluation and Forecast

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Abstract: To basically realize the modernization of "agriculture, rural and farmers" in western China by 2035 is the key goal to promote the development of western China. This paper constructs an evaluation index system and takes Japan and South Korea as the benchmark countries to analyze the modernization development of "agriculture, rural and farmers" in western China from 2015 to 2019. By using the Adaptive Recurrence Equal Dimension Gray Model, we predict whether the "agriculture, rural and farmers" in western China can basically achieve the modernization goal on time. The basic results show that the degrees of the modernization of agriculture, farmers and rural in western China are 62.14%, 47.52% and 52.73% in 2019, and the comprehensive index is 53.98%. From 2015 to 2019, the average annual growth rate is 0.04%, 7.40%, 5.39% and 3.91% respectively. Besides, the forecast result indicates that the comprehensive index will be 75.65% and the modernization of agriculture, farmers and rural in western China will be 65.56%, 75.29% and 82.6% in 2035. The existing problems include: insufficient agricultural development, low professional ability of the farmers, and the deficient rural governance ability. Therefore, western China should pursue agricultural development through science and technology, promote the transformation of farmers to professionalization and elitism, and improve rural governance capacity.

Keywords: western China; the basic realization of the modernization of "agriculture, rural and farmers"; Adaptive Recurrence Equal Dimension Gray Model

JEL Classification: Q01; Q18; Q58

1. Introduction

The basic modernization of "agriculture, rural and farmers" is a crucial part of achieving the long-term goals for 2035. The cultivated land area in western China accounts for 40.11% of the total national arable land area, and the number of rural employment accounts for 32.87%. It's a great strategic significance for China to realize the modernization of agriculture, rural areas and farmers in the western region as scheduled.

At present, although the modernization of "agriculture, rural and farmers" in western China has made great achievements under the western development strategy, there are still many problems to be solved urgently. In western China agricultural management is mainly decentralized, this s difficult for agriculture to form economies of scale (Luo, 2021). The farmers in general are poor and under-educated, lack vocational education and technical

training (Zhao, 2021). And the gap between urban and rural living standards is still large (Peng & Liu, 2020). These problems have become the key factors restricting the basic realization of modernization of agriculture, rural and farmers in the western region.

So, to what extent has the modernization of "agriculture, rural and farmers" in western China developed? How to evaluate it? What is the key factor hindering the modernization development of "agriculture, rural and farmers" in western China? Answering these questions will help to promote the development of the modernization of "agriculture, rural and farmers" in western China. It is crucial for western China to achieve the goal as scheduled.

Therefore, based on the data of western China from 2015 to 2019, this paper constructs the evaluation index system and takes Japan and South Korea as the benchmark countries to analyze the basic situation of the modernization development level of "agriculture, rural and farmers". On this basis, we use the Adaptive Recurrence Equal Dimension Gray Model to predict whether it will basically achieve the modernization goal on time and analyze the specific factors that hinder the development of agriculture, rural areas and farmers in western China.

2. Literature Review

2.1. The Definition of the Modernization of "Agriculture, Rural and Farmers"

In the relevant research on the definition of the modernization of "agriculture, rural and farmers", the scholars mostly discuss it from three aspects. In terms of agricultural modernization, Hong (2015) believes that the essence of agriculture modernization is the improvement of production efficiency, and the core is the scientific and technological progress. Chen (2018) argues that the modern agriculture should have developed infrastructure, advanced science and technology, efficient organization mode and perfect service system. And Yu (2018) proposes that the goal of agriculture modernization is to develop green productions for resource conservation and sustainable development. In terms of farmer modernization, Jiang and Li (2021) point out that farmer modernization includes modernization of farmers 'material and spiritual life, modernization of farmers' comprehensive quality and modernization of farmers' labor skills. In terms of rural modernization, Wei (2020) believes that rural modernization should be the organic whole of rural industrial modernization, rural culture modernization, rural ecological modernization, rural governance modernization and farmers' life modernization.

2.2. The Evaluation of the Modernization of "Agriculture, Rural and Farmers"

In recent years, scholars often adopt the multi-dimensional index comprehensive evaluation method, and there are two core problems in the evaluation process. One is how to determine the weight of the indicators, and the other is how to formulate the evaluation standards. In determining the weight, there are two methods: one is subjective empowerment, including Delphi, Hierarchical Analysis, etc.; the other is objective empowerment, including entropy, DEA, entropy TOPSIS, etc. Although the subjective empowerment method can reflect the importance of decision makers to different indicators, it has a certain arbitrariness and relatively poor objectivity. Relatively speaking, the objective empowerment method can solve the defects of subjective randomness.

3. Methodology

3.1. Theoretic Analysis

From a systematic perspective, the modernization of "agriculture, rural and farmers" is a unified organic whole. Agricultural modernization is the foundation. The realization of agricultural modernization means the improvement in agricultural production efficiency, increasing farmers' operating income and improving their qualities of life, and modern agriculture requires employees to master more advanced production technology and management means, forcing farmers to learn advanced agricultural knowledge and work skills, constantly improve their comprehensive quality and professional ability, and promote their modernization. In addition, modern agriculture not only pays attention to efficient production, but also to green production. The development of green agriculture will greatly improve the rural ecological environment, which is an essential link to the construction of building a modern countryside.

Farmer modernization is the core. Both agricultural modernization and rural modernization must be realized through continuous practice and innovation of modern farmers. With the high human capital, modern farmers have richer agricultural science knowledge and master more advanced agricultural production technology to continuously promote the development of agricultural modernization. The modern farmers with the high income and open thoughts will put forward the higher requests for their living environment, so as to promote the construction of a modern countryside with convenient life service and excellent ecological environment.

Rural modernization is the guarantee. Modern rural for farmer modernization provides a solid rear security. Modern rural areas which have the convenient life service facilities, perfect education and medical service system and high quality living ecological environment, not only can retain original farmers, and prompt its constantly to modern farmers, but also can attract other residents to settle in modern rural areas, attract quality talents for modern agricultural development, indirect reserve talents for agricultural modernization development.

Therefore, when evaluating the modernization of agriculture, rural areas and farmers in western China, we should choose a comprehensive method to evaluate the various aspects of the modernization development of agriculture, rural areas and farmers. The Multidimensional Index Comprehensive Evaluation Method is the most effective and accurate method for evaluation in this aspect. It can not only reflect the comprehensive results of each index, but also reflect the importance of different indicators according to the weight of the indicators.

So, this paper chooses the Multidimensional Index Comprehensive Evaluation Method to calculate the degree of the modernization of "agriculture, rural and farmers" in western China. In this process, determining the method of criteria for evaluation and the indicator weights is the most important thing. The modernization of "agriculture, rural and farmers" is a dynamic process, and the development characteristics of different regions are different. So only by determining a benchmark with the modernization level of "agriculture, rural and farmers" in the current

development stage can the development degree of the modernization of "agriculture, rural and farmers" be objectively and comparatively measured. Therefore, this paper chooses the Management by Objectives Evaluation Method to determine the evaluation criteria and choose the objective empowerment method to determine the indicator weights as mentioned above.

Table 1. The index system of modernization of "Agriculture Rural and Farmers" (Source: National Bureau of Statistics)

Guide Layer	Theoretical Layer	Specific Indicators(unit)	Direction
Agriculture Modernization	Modernization of agricultural industrial system	1Proportion of livestock production value (%)	+
		2Ratio of agricultural and sideline food processing industry to agricultural output value	+
		3Yield per unit area of melons and fruits (kg/ha)	+
		4Proportion of output value of agriculture, forestry, animal husbandry and fishery services (%)	+
	Modernization of agricultural production system	5Grain output per unit area (kg/ha)	+
		6Mechanization degree (set/100 square kilometers)	+
		7Fertilizer usage (kg/ha)	-
		8Pesticide application (kg/ha)	-
	Modernization of agricultural management system	9Agricultural labor productivity (yuan/per)	+
Farmer Modernization	Modernization of farmers' life	10Per person disposable income(yuan/per)	+
		11Per person consumption expenditure(yuan/per)	+
		12Engel's coefficient	-
		13Rural household car penetration rate (vehicles)	+
		14Proportion of rural poor (%)	-
	Modernization of farmers' ideology	15Proportion of education, culture and entertainment expenditure (%)	+
	Modernization of farmers' professional ability	16Compulsory education popularization rate (%)	+
		17Proportion of agricultural employees (%)	-
Rural Modernization	Rural public service modernization	18Popularity of standard hardened roads in rural areas (%)	+
		19Rural Internet penetration rate (%)	+
		20Rural water supply penetration rate (%)	+
		21Per person domestic electricity consumption of rural residents(kWh)	+
		22Average number of village clinics per 1000 rural population (person)	+
		23Rural gas penetration rate (%)	+
		24Teacher student ratio of full-time teachers in rural junior middle schools	+
	Modernization of rural human settlements	25Domestic sewage treatment rate (%)	+
		26Domestic waste disposal rate (%)	+
		27Prevalence rate of harmless sanitary toilets (%)	+
		28Rural green coverage rate (%)	+
	Modernization of rural governance system	29Percentage of villages with village and town management institutions (%)	+
		30Percentage of villages where the secretary of the village party organization concurrently serves as the director of the village committee (%)	+

3.2. The Index System Establishment

The index system constructed includes 3 targets in grade 1, 9 targets in grade 2 and 30 in grade 3. The details are shown in Table 1 above.

3.3. The Target Value Determination

The basic modernization of "agriculture, rural and farmers" is a stage in the process of modernization. It is a further upgrading on the basis of the initial modernization, but its development level is not enough to reach the full realization of modernization. The fifth plenary session of the 19th pointed out that in 2035 the basic realization of socialist modernization vision including "per capita gross domestic product (GDP) reached the level of moderately developed countries", according to this standard, the selected 2035 "agriculture, rural and farmers" basic realization of socialist modernization vision for the per capita GDP of the current "agriculture, rural and farmers" modernization development level. However, there are many countries with per capita GDP reaching a moderately developed level, and there are differences in the resource endowment and production factors for the modernization development of "agriculture, rural and farmers" in different countries. This paper follows three guidelines when choosing benchmark countries:

- Rule 1: Select the benchmark countries according to the per capita GDP development level. According to the World Economic Outlook compiled by the International Monetary Fund (IMF), the median per capita GDP of the 39 developed economies in 2019 was $43,603.01, and the arithmetic average was $45,604.74. Therefore, countries with per capita GDP approaching $43,000 were selected as benchmark countries.
- Rule 2: Select the benchmark countries according to the geographical proximity. Among these developed countries, Asian countries have a closer geographical distance and more similar natural resources to China. Therefore, this paper selects Asian countries as benchmark countries in the moderately developed countries.
- Rule 3: Select the benchmark countries according to the similarity in production factors. Among the moderately developed countries in Asia, Japan and South Korea have a more similar cultural origin, entrepreneurship, capital preference, and production technology level with China. Therefore, in the moderately developed countries in Asia, Japan and South Korea are selected as the benchmark countries.

According to the above three rules, the average level of Japan and South Korea in 2019 is selected as the target value of basically realizing the modernization of the "agriculture, rural and farmers" in the western region.

3.4. Evaluation Methods

First, Indicator consistency processing. Due to the difference in the index direction of specific indicators, this paper uses the reciprocal consistency to treat the reverse index into the positive index. Second, the data is dimensionless for processing. This paper follows the method of 2019 by Liu et al. (2019), standardizing the specific indicators by the Z-score method, and then the standard normal cumulative probability value of the standardized

data is found, and the data is converted into a range between 0 and 1. Third, determine the index weight. In order to maximize the differences between the evaluated objects, the weight is determined by the "vertical and horizontal direction" and the grade expansion method.

3.5. Data Source

This paper selects the sample data of 12 provinces in western China from 2015 to 2019. For individual missing data, refer to the practice of Di and Hu (2020), choose the data with the closest year of the same index to replace. The sample data are all obtained from the 2016-2020 China Statistical Yearbook, China Rural Statistical Yearbook, China tertiary Industry Statistical Yearbook, China Science and Technology Statistical Yearbook, China Education Statistical Yearbook, China Environmental Statistical Yearbook and China Household Survey Yearbook.

The average level of Japan and South Korea in 2019 is selected as the target value of the basically realizing the modernization of the "agriculture, rural and farmers" in western China. Most data come from World Bank NAOCD, ILO, FAO, WDI database, OECD OLIS database, and Wind database. But some data from Japan and South Korea are not available due to differences in statistics or national policies. This target value is to draw on the research results of the research group of the Rural Economic Research Department of the Development Research Center of The State Council in 2020 by Research Group of the Rural Economic Research Department of the Development Research Center of the State Council et al. (2021), or is to calculate the level of 2035 according to the average target of the Rural Revitalization Strategic Plan 2018-2022, formulated by the state.

4. Results

4.1. Specific Indicators Analysis Results

From 2015 to 2019, the specific indicators of modernization of agriculture, rural and farmers in western China are shown in Table 2. In 2019, among the nine specific indicators of agricultural modernization in western China, one index is above 90%, 3 between 80-90%, two between 60-80%, three under the 60% including agricultural labor productivity, output value of agriculture, forestry, animal husbandry, fishery and service industry, and pesticide application. Low agricultural labor production efficiency in western China is mainly due to natural conditions such as terrain, precipitation. Agricultural production and operation is difficult to form the scale, it causes surplus agricultural labor forces, and low demand of large agricultural machinery tools, that limit the modern science and technology in western China agriculture, makes the western region in the process of agricultural modernization shows the characteristics of labor production efficiency is low.

Among the eight indicators of farmers' modernization, in 2019, one indicator is above 90%, 2 are between 60-80%, and 5 are below 60%, among which the per capita consumption expenditure of farmers accounted for less than 10%. The improvement to farmers' consumption level is closely related to increasing farmers' income. From the perspective of income structure, the income source of rural residents in western China in 2019 is mainly

Table 2. The degree of realization of specific indicators of "Agriculture, Rural and Farmers" modernization in Western China from 2015 to 2019

Specific Indicators(unit)	2015	2016	2017	2018	2019
1Proportion of livestock production value (%)	80.81	84.77	79.78	77.60	81.02
2Ratio of agricultural and sideline food processing industry to agricultural output value	17.07	15.79	25.40	45.68	68.78
3Yield per unit area of melons and fruits (kg/ha)	94.14	94.58	94.83	95.28	97.78
4Proportion of output value of agriculture, forestry, animal husbandry and fishery services (%)	40.22	38.89	39.95	39.90	39.03
5Grain output per unit area (kg/ha)	83.20	83.35	83.81	85.93	86.88
6Mechanization degree (set/100 square kilometers)	71.73	71.78	74.80	71.92	72.03
7Fertilizer usage (kg/ha)	99.28	97.87	99.29	95.15	89.86
8Pesticide application (kg/ha)	56.56	57.04	52.42	47.84	44.65
9Agricultural labor productivity (yuan/per)	12.48	13.09	13.61	14.78	15.79
10Per person disposable income (yuan/per)	8.58	9.34	10.22	11.18	12.33
11Per person consumption expenditure (yuan/per)	5.86	6.40	6.98	7.63	8.39
12Engel's coefficient	64.29	66.77	69.77	74.21	74.36
13Rural household car penetration rate (vehicles)	29.88	35.88	39.30	43.34	48.51
14Proportion of rural poor (%)	5.78	7.43	10.23	20.49	53.59
15Proportion of education, culture and entertainment expenditure (%)	88.91	91.00	91.10	93.73	94.51
16Compulsory education popularization rate (%)	65.40	65.63	68.76	69.04	69.61
17Proportion of agricultural employees (%)	9.03	9.24	9.46	9.65	9.91
18Popularity of standard hardened roads in rural areas (%)	31.28	35.43	37.39	41.03	43.00
19Rural Internet penetration rate (%)	16.22	21.52	29.89	42.53	51.58
20Rural water supply penetration rate (%)	70.65	72.59	84.07	88.52	91.81
21Per person domestic electricity consumption of rural residents(kWh)	30.05	31.72	34.43	36.65	39.82
22Average number of village clinics per 1000 rural population (person)	71.67	71.03	75.35	79.68	82.09
23Rural gas penetration rate (%)	24.08	24.59	29.56	28.65	32.13
24Teacher student ratio of full-time teachers in rural junior middle schools	53.29	52.54	52.36	50.91	50.81
25Domestic sewage treatment rate (%)	12.86	13.07	18.47	24.97	25.92
26Domestic waste disposal rate (%)	58.47	67.91	67.54	66.00	73.66
27Prevalence rate of harmless sanitary toilets (%)	60.07	62.15	65.92	67.06	69.33
28Rural green coverage rate (%)	14.16	14.98	15.38	15.91	17.63
29Percentage of villages with village and town management institutions (%)	70.17	73.37	73.06	73.74	74.60
30Percentage of villages where the secretary of the village party organization concurrently serves as the director of the village committee (%)	38.75	37.37	32.44	30.20	27.96

[1]Source: Calculated by the author.

family operating net income. Therefore, the key to farmers' modernization is to improve farmers' ability in agricultural production and operation to increase the income of agricultural production and operation. From 2015 to 2019, although the proportion of agricultural employees in western China is increasing year by year, the growth rate is slow. In 2019, the realization degree of this

index was only 9.91%. It reflects that with moderately developed countries as the target, there are still a large number of redundant labor forces engaged in agriculture in western China, and the training speed of high-quality agricultural talents is very slow. In the future, the western China should intensify efforts to cultivate talents who can master advanced agricultural labor skills, and improve the professional ability and cultural quality of farmers.

Among the 13 specific indicators of rural modernization, 1 indicator is achieved above 90% in 2019, 1 is between 80 and 90%, 3 are between 60 and 80%, and 8 are less than 60%. From 2015 to 2019, most indicators showed a rapid growth trend. These significant improvement of the living conditions of rural residents is due to the country's increasing attention to the construction of beautiful countryside. However, in the modernization of the rural governance system, the proportion of the target between the village party secretary and the director of the village committee is decreasing year by year, with only 27.96% in 2019. Central file no. 1, 2019 pointed out that the problem of the urban and rural factors flow and unreasonable allocation of public resources are still outstanding. To reshape the new urban-rural relations, we need to implement the village party secretary through legal procedures as director of the village committee, guide its rural service.

4.2. Comprehensive Indicators Analysis Results

The realization degree of the comprehensive modernization index of "agriculture, rural and farmers" in western China from 2015 to 2019 is shown in Table 3.

Table 3. The realization degree of comprehensive indicators of "Agriculture, Rural and Farmers" modernization in Western China from 2015 to 2019 (%)

Year / Indicators	2015	2016	2017	2018	2019
Agriculture Modernization	62.03	62.17	62.96	61.96	62.14
Farmer Modernization	35.71	37.39	39.17	42.14	47.52
Rural Modernization	42.73	44.87	47.76	50.03	52.73
"Agriculture, Rural and Farmers" Modernization	46.31	47.75	49.72	51.25	53.98

On the whole, the comprehensive index in western China in 2019 increased by 7.67% compared with 2015, with an average annual growth rate of 3.91%. The growth rate showed a growing trend, which reflects that the modernization of "agriculture, rural and farmers" in western China is improving. Among the comprehensive indicators, the highest is agricultural modernization in 2019 is 62.14%, but it only increases 0.11% compared to 2015, with an average annual growth rate of 0.04%; Farmer modernization in 2019 is 47.52%, up 11.81% from 2015 and an average annual growth rate is 7.40%, rural modernization is 52.73% in 2019, up 10% from 2015, with an average annual growth rate of 5.39%.

5. Forecast Analysis

5.1. Forecast Method

This paper uses Adaptive Recurrence Equal Dimension Gray Model to predict the modernization of "agriculture, rural and farmers" in western China. GM (1,1), which is the basic

model, accumulates the complex data to generate regular series. In the modeling process, the results of the next stage are continuously reflected. After many cycles, the whole model gradually tends to improve. However, GM (1,1) model is mainly suitable for the prediction of short-term data, and it is difficult to make long-term prediction, because it does not consider its dynamic variability when setting the gray parameter estimation value in the algorithm, resulting in the longer the prediction dimension, and the lower the prediction accuracy.

The idea of dimensional complement is using GM (1,1) model, calculating the known series to get the predicted value, and then adds the new prediction value to the known series, deletes the most backward data in the sequence, to ensure that the dimension of the sequence does not change, and then with the new sequence as the next prediction of the original sequence. And then repeat the above process, until complete the prediction target.

5.2. Prediction Model Accuracy Test

The forecast results and forecast errors of the modernization of "agriculture, rural and farmers" in western China in 2015-2019 are shown in Table 4. The average relative error is 0.39%, the forecast accuracy is 99.61%, the posterior difference ratio is 0.0788, less than 0.5, which meets the requirements of the gray prediction model accuracy test. That means, the model prediction effect is good.

Table 4. Model prediction of the comprehensive indicators of "Agriculture, Rural and Farmers" modernization in Western China from 2015 to 2019[1]

Year	Actual Value	Estimate Value	Absolute Error	Relative Error
2015	46.31	46.31	0	0
2016	47.75	47.67	0.08	0.0017
2017	49.72	49.61	0.11	0.0022
2018	51.25	51.64	-0.39	-0.0076
2019	53.98	53.75	0.23	0.0042

Note: Calculated by the forecast value calculation formula of the GM (1,1).

5.3. Forecasting Result

The predicted results are shown in Table 5. Among the indicators of agricultural modernization, three of them reach 100%, and 2 reach 60-70%, 4 are under 60%. That means, according to the current level of agricultural development in moderately developed countries, the problems of low output value of agriculture, forestry, animal husbandry and fishery service industry, excessive use of chemical fertilizers and pesticides, and low agricultural labor productivity mainly exist in western China.

In the term of farmer modernization, four indicators reach 100%; 1 reaches 90-100%, 3 under 60%, which are per capita disposable income, per capita consumption expenditure and the proportion of agricultural employees. That means, the main problems in the process of the basic modernization of farmers in western China are their low income level, insufficient consumption capacity and too high proportion of agricultural practitioners.

There are 13 indicators in rural modernization dimension, 9 indicators reach 100%, 1 is between 80-90%; 3 are below 60%. That means, the main problems in the process of rural

Table 5. Predicted score of the basic modernization of "Agriculture, Rural and Farmers" in Western China in 2035 (%)

Specific Indicators(unit)	Score
1Proportion of livestock production value (%)	60.00
2Ratio of agricultural and sideline food processing industry to agricultural output value	100.00
3Yield per unit area of melons and fruits (kg/ha)	100.00
4Proportion of output value of agriculture, forestry, animal husbandry and fishery services (%)	40.14
5Grain output per unit area (kg/ha)	100.00
6Mechanization degree (set/100 square kilometers)	69.01
7Fertilizer usage (kg/ha)	57.39
8Pesticide application (kg/ha)	11.74
9Agricultural labor productivity (yuan/per)	44.21
10Per person disposable income (yuan/per)	52.95
11Per person consumption expenditure (yuan/per)	34.65
12Engel's coefficient	100.00
13Rural household car penetration rate (vehicles)	100.00
14Proportion of rural poor (%)	100.00
15Proportion of education, culture and entertainment expenditure (%)	93.12
16Compulsory education popularization rate (%)	100.00
17Proportion of agricultural employees (%)	14.30
18Popularity of standard hardened roads in rural areas (%)	100.00
19Rural Internet penetration rate (%)	100.00
20Rural water supply penetration rate (%)	100.00
21Per person domestic electricity consumption of rural residents(kWh)	100.00
22Average number of village clinics per 1000 rural population (person)	100.00
23Rural gas penetration rate (%)	100.00
24Teacher student ratio of full-time teachers in rural junior middle schools	41.22
25Domestic sewage treatment rate (%)	100.00
26Domestic waste disposal rate (%)	100.00
27Prevalence rate of harmless sanitary toilets (%)	100.00
28Rural green coverage rate (%)	40.75
29Percentage of villages with village and town management institutions (%)	81.75
30Percentage of villages where the secretary of the village party organization concurrently serves as the director of the village committee (%)	5.85

modernization in western China are the low ratio of rural compulsory education, the low green coverage rate and the imperfect rural governance system.

The predicted scores of the basic modernization of "agriculture, rural and farmers" in western China from 2020 to 2035 are shown in Table 6. From the prediction results, we find that without external intervention and continuing to develop according to the current trend, it will not achieve the basic realization of the modernization goal in 2035.

On the whole, the comprehensive index is only 75.65% in 2035, and the average growth rate is 2% from 2020 to 2035. The agricultural modernization in western China grows the slowest, the average annual growth rate of 0.34%. According to the current growth trend, only 65.56% of agricultural modernization in western China by 2035. The modernization of farmers grew the fastest, the average growth rate of 2020 to 2035 is 2.79%. By 2035, the modernization

of farmers will be 75.29%. The average growth rate of rural modernization will be 2.59% from 2020 to 2035, In 2035, the realization degree of rural modernization will be 82.60%.

Table 6. Predicted Score of the Comprehensive Indicators of the Basic Modernization of "Agriculture, Rural and Farmers" in Western China from 2020 to 2035 (%)[1]

Year	Agriculture Modernization	Farmer Modernization	Rural Modernization	"Agriculture, Rural and Farmers" Modernization
2020	62.29	49.83	56.22	56.18
2021	62.54	57.00	59.61	59.72
2022	62.92	58.76	62.34	61.50
2023	63.36	60.63	64.53	63.10
2024	63.99	62.44	66.68	64.72
2025	64.83	64.40	69.13	66.57
2026	65.89	66.51	71.16	68.34
2027	67.20	67.76	72.68	69.73
2028	67.05	68.49	74.30	70.59
2029	66.79	69.27	76.04	71.48
2030	66.49	70.10	77.80	72.39
2031	66.23	70.99	79.49	73.30
2032	66.01	71.95	80.81	74.07
2033	65.82	72.99	81.55	74.63
2034	65.67	74.10	82.27	75.20
2035	65.56	75.29	82.60	75.65

6. Discussion

This paper expands the existing research from the following aspects: First, most scholars focus more on the importance of agricultural modernization and rural modernization, such as Tu (2023) and Zhou (2023). They often put the modernization of farmers in a secondary position, or even missing, ignoring the modernization of farmers is an essential part of agricultural modernization and rural modernization. This paper puts forward the modernization of "agriculture, rural and farmers" is a unified organic, proposes that the realization process is divided into three stages: preliminary realization of modernization, basic realization of modernization and comprehensive realization of modernization. Second, the modernization of "agriculture, rural and farmers" is a dynamic process, and the development characteristics of different regions are different, only by determining a benchmark in line with the modernization of "agriculture, rural and farmers" in the current development stage can it be objectively and comparatively measured. However, there are few academic researches on how to determine the benchmark of the modernization of "agriculture, rural and farmers". This paper uses the management of objectives evaluation method, according to the three guidelines, chooses Japan and South Korea as the benchmark countries. Third, scholars always choose GM (1,1) to do prediction when the time range of data is so short (Liu, 2022). But it's difficult to do the long-term prediction by GM (1,1) because as the predict gap widens, the prediction accuracy will decrease. This paper selects gray adaptive isodimensional complemented prediction model to overcome this problem in order to improve the accuracy of the prediction results.

7. Conclusions and Recommendations

7.1. Conclusions

In this paper, the following three conclusions are drawn: Firstly, in 2019, the comprehensive index of modernization of agriculture, rural and farmers in western China was 53.98%, The realization degree of agricultural modernization was 62.14%, The degree of modernization realization of farmers was 47.52%, rural modernization was achieved to 52.73%, the average growth rate from 2015 to 2019 were 3.91%, 0.04%, 7.40% and 5.39%. Secondly, according to the current trend of modernization of agriculture, rural and farmers in western China, the modernization goal cannot be achieved in 2035. The forecast results show that the realization of modernization in western China in 2035 is 75.65%. The modernization of agriculture, farmers and rural are 65.56%, 75.29%, 82.6%. That means, the biggest problem is the modernization of the agriculture. Thirdly, combined with the specific indicators in the western region in 2035, the problems in agriculture are low agricultural fishery services output ratio, unreasonable use of pesticides and fertilizers and low agricultural labor productivity, farmers modernization problem is that farmers' low disposable income, insufficient consumption ability and agricultural workers ratio, rural modernization problem is rural compulsory education resources still does not reach the designated position, low green coverage and rural governance ability remains to be improved.

7.2. Recommendations

Based on the conclusions of this research and combined with the current situation of agricultural development in China, the policy recommendations of this paper include the following three aspects:

1. Increase support for agriculture, forestry, animal husbandry, fishery and services, and extend the agricultural industrial chain. In the era of digital economy, western China should play the advantages of digital technology, with the help of agricultural service organizations to provide professional, scale services, realizes centralized and unified production, unified processing, unified sales as the integration of the whole industry chain, promote agriculture, forestry and fishery service value is steadily increased. And controlling the use of agricultural chemical fertilizers and pesticides and developing green agriculture, continuing to make science and technology enable agricultural modernization and improve agricultural labor productivity is important as well.
2. Try to raise farmers' agricultural operating income and increase their income level and consumption capacity. The government can help farmers by vigorously cultivating leading agricultural enterprises and supporting industries with characteristics, brand cultivation, marketing and other aspects. Meanwhile, promote the professional development of farmers and train the elite agricultural labor force also are urgent matters. Such as promoting the western region farmers to professional, elite transformation, reducing agricultural redundant personnel, at the same time selecting skilled use of agricultural professional skills, with agricultural modernization management knowledge of agricultural talents, to improve the farmers' professional ability, optimize the agricultural labor force.

3. Intensify rural greening construction and build a beautiful countryside in western China. By the introduction of professional and technical personnel, give financial subsidies, with the construction team with strong business ability to carry out the rural greening project in the western region, the integration of social capital resources, to provide technical protection for rural greening and financial construction work.

7.3. Limitation and Prospects

This paper still has limits that can be break in the future. Such as, choosing the Japan and South Korea as the benchmark countries make the evaluation more accurate, but actually there are many different situations between western China and them. Is there better benchmark? If so, how to find it? Based on this paper, the backward agriculture is the biggest problem in the process of the modernization of "agriculture, rural and farmers" in western China, but what is the key driving force to promote the modern development of agriculture? How to inspire it? Answering these problems will be the next step to do in the future.

Conflict of interest: none

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Dependence of Corporate Income Tax Revenue on the Gross Domestic Product in Particular EU Countries

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Abstract: The presented research deals with corporate income tax in the countries of the European Union. Specifically, the subject of the investigation was the income tax base, tax rates, and income tax revenue in particular EU countries. The ratio of corporate income tax revenues to gross domestic product (GDP) is compared using correlation analysis tools. The research outputs mean that the volume of corporate income tax revenue is strongly dependent on the size of the given economy. Luxembourg has the highest corporate income tax revenue ratio to gross domestic product. In Luxembourg, this ratio is 5.92%. Lithuania has the lowest value of the ratio, where a decreasing trend can be noted between 2009 and 2019, down to 0.16%. Based on the prediction based on the values in the numerical series, a steady increase in the ratio of corporate income tax revenue to GDP can be predicted in the Czech Republic in the next five years up to 3.87%.

Keywords: corporate income tax; gross domestic product; tax rate

JEL Classification: E42

1. Introduction

The tax rate is the procedure by which can be determined the tax amount from the tax base. The tax rate has several types. For corporate income tax, there are the following types:

- Differentiated tax rate, which differs according to the tax subject. The lower rate applies to, for example, pension companies or investment funds.
- The relative tax rate is used where the tax base is expressed in monetary units, so the tax rate is expressed in percentages.

The relative tax rate is divided into a linear rate, where the amount of tax increases proportionally with the tax base, and a progressive rate, where the algorithm continuously increases the rate of taxation for individual increments of the tax base. (Vančurová et al., 2020). Malta has the highest corporate tax rate, but limited companies can claim 6/7 back. Thus, Malta's tax rate would move to the other end of the scale. (Parker & Hill, 2021). The relative tax rates are shown in Table 1.

Markle and Shackelford (2012) examined the impact of domicile on corporate taxes. They found that the country where the parent of a multinational is located and, to a lesser extent, its subsidiaries are located substantially affects its worldwide effective tax rate (ETR).

Table 1. Relative corporate income tax rate in EU countries – source: (Tax Foundation, 2020)

2018		2019		2020	
MT	35%	MT	35%	MT	35%
FR	33%	FR	31%	DE	30%
DE	30%	DE	30%	BE	29%
BE	29%	BE	29%	FR	28%
EL	29%	EL	28%	EL	24%
LU	26.01%	AT	25%	AT	25%
AT	25%	NL	25%	NL	25%
NL	25%	ES	25%	ES	25%
ES	25%	LU	24.94%	LU	24.94%
IT	24%	IT	24%	IT	24%
SE	22%	SE	21.40%	SE	21.40%
DK	22%	DK	22%	DK	22%
PT	21%	PT	21%	PT	21%
SK	21%	SK	21%	SK	21%
LV	20%	LV	20%	LV	20%
FI	20%	FI	20%	FI	20%
EE	20%	EE	20%	EE	20%
CZ	19%	CZ	19%	CZ	19%
SI	19%	SI	19%	SI	19%
PL	19%	PL	19%	PL	19%
HR	18%	HR	18%	HR	18%
RO	16%	RO	16%	RO	16%
LT	15%	LT	15%	LT	15%
IE	12.5%	IE	12.5%	IE	12.5%
CY	12.5%	CY	12.5%	CY	12.5%
BG	10%	BG	10%	BG	10%
HU	9%	HU	9%	HU	9%
MT	35%	MT	35%	MT	35%
FR	33%	FR	31%	DE	30%
DE	30%	DE	30%	BE	29%
BE	29%	BE	29%	FR	28%
EL	29%	EL	28%	EL	24%
LU	26.01%	AT	25%	AT	25%
AT	25%	NL	25%	NL	25%
NL	25%	ES	25%	ES	25%
ES	25%	LU	24.94%	LU	24.94%

Corporate income tax rates also affect the amount of corporate tax revenue in individual sectors of the economy, as well as the contribution of a given economic sector to the national budget. Cheben et al. (2021) found that in the period 2011–2015 the tax revenue of Agriculture, forestry and fishing companies in Slovakia constituted 1.6% of the Slovak state budget.

Souillard (2022) shows the impact of the corporate income tax rate on employment tax optimization. Souillard (2022) summarizes the research results as follows: "Study reveals that all other things being equal, the establishment of tax haven subsidiaries is followed by a 4 percent rise in firm employment in the subsequent years. This finding offers greater insight into how corporate income taxes affect employment levels."

Malecka-Ziembinska and Siwiec (2020) dealt with the differentiation of corporate income tax bases in EU countries. They investigated the possibilities of harmonization of the bases of this tax. Their research results show that despite significant differences in tax rates some EU states show convergence in tax bases. Similar research, but with a much broader index of the countries examined, was also published by Steinmuller et al. (2019). Uniformity versus diversity corporate income tax was also investigated by McLure (2008). McLure (2000) also published an interesting article analyzing aspects of corporate income tax in the digital age. McLure (2020) deals with the choice between separate reporting and formula apportionment, the role of unitary combination, and the choice of apportionment factors). Several European countries are now discussing a digital tax, so this article can inspire these considerations.

Gupta and Jalles (2021) deal with the tax implications of the COVID-19 pandemic (as well as other pandemics). It states: „We estimate that the short- to medium-term fiscal impact of previous pandemics has been significant in 170 countries (including low-income countries) during the 2000–2018 period. The impact has varied, with pandemics affecting government expenditures more than revenues in advanced economies, while the converse applies to developing countries."

The structural deficits of the state budgets lead several European countries to discussions about the rate of taxation of corporations and the rate of taxation of employees. An exciting conception of this dilemma from a non-European environment (from Colombia) is offered by Bernal et al. (2017): „The 2012 Colombian tax reform reduced payroll taxes and employer contributions to health insurance by 13.5 percent, while also increasing corporate income taxes and leaving untouched the benefits to workers financed through these taxes… We find a positive average effect of 4.3 percent on employment and 2.7 percent on average firm wages, for the average firm. The employment effect is found only for micro and small firms, whereas the bulk of the employment is concentrated in medium and large firms, which show no significant effect. According to these estimates, about 145,000 new jobs were created between January and May of 2015 by virtue of the reform."

Park and Lee (2019) also investigated the relationship between corporate income tax and household taxation. It states the following: „We find that corporate income tax (CIT) rates are significantly positively associated with corporate debt and negatively associated with household debt, using panel data of 28 OECD countries between 1995 and 2015. The found association between CIT and debt comes from small countries where CIT is more exogenous due to tax competition. The tax deductibility of interest payments encourages firms to use more debt when CIT is high."

Lee (2020) compared the tax burden of corporate income tax and personal income tax. Lee (2020) states as a result of this comparison: "This paper empirically investigates tax competition in corporate income taxes (CIT) and personal income taxes (PIT) in 67 countries between 1981 and 2015. We find that tax competition in PIT is weaker than that in CIT, and various domestic considerations appear to act strongly in determining PIT. "

Gong and Ligthart (2015) show the effects of corporate income tax on bank behavior: "Using a sample of OECD banks over the period 1999–2006, we find that corporate income

taxation led to more securitization at banks that are constrained in funding markets, while it did not affect securitization at unconstrained banks."

Prochazka and Cerna (2022) draw attention to the fact that the corporate income tax rate affects the rate of reinvestment: „Our research shows that the corporate income tax (CIT) rate and ETRs significantly correlate with the reinvestment rate. The same applies to three Ease of Doing Business sub indicators (Starting a business, Getting credit, and Contract enforcement)."

However, the corporate income tax revenue does not depend only on the tax rate. Tahlova and Banociova (2019) analyze the influence of several other tax determinants. This article describes the impact of tax legislation and specific non-tax factors on the amount of tax revenue.

Table 2 below contains the value of GDP in billions of USD for particular European countries.

Table 2. GDP in billions of USD (OECD, 2020)

EU country	2016	2017	2018	2019	2020
AT	394.22	417.72	456.17	447.72	432.89
BE	469.93	495.95	532.27	517.61	503.42
BG	53.81	58.97	66.23	68.56	69.11
CY	20.95	22.73	25.31	24.95	23.8
CZ	195.09	215.91	245.23	246.95	241.98
DE	3,496.61	3,664.51	3,951.34	3,863.34	3,780.55
DK	311.99	329.87	352.06	347.18	339.63
EE	23.99	26.85	30.76	31.04	30.47
EL	195.30	203.49	218.23	214.01	194.38
ES	1,238.01	1,317.10	1,427.53	1,397.87	1247.46
FI	239.15	252.87	274.21	269.65	267.86
FR	2,466.15	2,591.78	2,780.15	2,707.07	2,551.45
HR	51.60	55.48	61.38	60.75	55.97
HU	126.01	139.84	161.18	170.41	149.94
IE	301.97	335.21	382.75	384.94	399.06
IT	1,869.97	1,950.70	2,075.86	2,001.44	1,848.22
LT	27.71	30.53	34.88	35.05	33.02
LU	58.99	62.45	69.55	69.45	68.61
LV	42.99	47.65	53.30	53.64	55.06
MT	11.72	13.22	14.86	15.22	14.65
NL	783.85	833.58	914.52	902.36	886.34
PL	471.84	526.75	585.82	565.85	580.89
PT	206.36	221.28	240.90	236.41	221.72
RO	188.10	211.70	241.50	249.7	248.7
SE	512.21	540.55	556.07	528.93	529.05
SI	44.66	48.55	54.06	54.15	51.8
SK	89.89	95.82	106.57	106.55	101.892
UK	2,693.00	2,662.00	2,662.00	2,831.00	2,708.00

Gechert and Heimberger (2022) remind us that „The empirical literature on the impact of corporate taxes on economic growth reaches ambiguous conclusions: corporate tax cuts increase, reduce, or do not significantly affect growth."

Shao and Xiao (2019) point to the causality of corporate tax policy on firm innovation in a developing country.

Dunaev (2019) analyzes the relationship between the optimal corporate income tax rate and GDP. Dunaev (2019) determines the optimal production income tax rate at which net profit and state budget revenue steadily increase and stable growth of production is ensured. Dunaev (2019) states: "For a lower rate, there is an accelerated growth in production, and for a higher rate, the budget revenue increases due to a slowdown in production growth."

Table 3 contains the 2017–2019 corporate income tax revenue in billions USD.

Table 3. Corporate income tax revenue in billions of USD (OECD, 2020)

EU country	2017	2018	2019
AT	114.65	126.52	124.42
BE	113.11	125.23	115.52
BG	1.36	1.49	1.58
CY	1.33	1.47	1.41
CZ	41.73	47.65	47.55
DE	409.88	450.91	439.18
DK	110.34	114.66	118.47
EE	7.17	8.27	8.54
EL	52.72	57.03	53.78
ES	182.56	205.13	194.51
FI	52.89	57.46	55.55
FR	407.50	429.63	407.29
HR	1.26	1.37	1.40
HU	33.62	36.45	35.72
IE	62.95	71.80	72.75
IT	472.98	495.88	484.00
LT	5.05	5.66	5.38
LU	16.24	19.27	18.92
LV	7.93	9.01	10.85
MT	0.81	0.78	0.83
NL	192.09	210.58	218.6
PL	88.41	102.18	103.31
PT	50.62	56.11	54.51
RO	4.26	4.85	5.24
SE	125.74	127.34	117.99
SI	8.88	10.03	9.95
SK	18.30	20.31	20.42
UK	660.65	708.24	698.29

The volume of corporate income tax revenue in particular EU countries strongly depends on the size of the given economy. It can be stated that in most states, corporate income tax revenue increases over time. The volume of tax revenue increased the most in Great Britain and the Netherlands. On the contrary, the largest decrease occurred in Sweden, by almost 8 billion USD. The same trend can be seen in all the decreases, namely that in 2018 the volume of tax revenue was the highest of the monitored years and only decreased in 2019.

The Laffer curve describes the dependence of the tax revenue on the tax rate. Its conventional shape, including only one peak, is subject to reservations by several contemporary economists. Tavor et al. (2021) examine a modification of the Laffer curve with three peak points. Tavor et al. (2021) conclude their research as follows: "Such a shape may

be due to the three heterogeneous population groups of younger workers, adult males, and adult females. These groups respond differently to net wage rate changes, thus reducing the applicability of the changing of tax rates by policymakers."

Factors affecting income tax revenue are described by Garcia (2022). These factors include technological outdatedness, the effects of inflation, and the lack of compliance and accountability from taxpayers.

2. Methodology

The objective of the research was to determine the dependence of the corporate income tax of companies operating on the territory of particular EU countries on GDP.

The formula for the general correlation coefficient was used to calculate the dependence mentioned above. The correlation coefficient measures the strength of the linear relationship between two variables. In the case of the presented research. the compared variables are tax revenues and gross domestic product.

The following formula was used to calculate the general correlation coefficient:

$$r_{yx} = r_{xy} = n \Sigma x_i * y_i - \Sigma x_i \Sigma y_i / \sqrt{[n \Sigma x_i^2 - (\Sigma x_i^2 – (\Sigma x_i)^2] * [n \Sigma y_i^2 – (\Sigma y_i)^2]} \quad (1)$$

where n is the number of assessed EU countries. x is the explanatory variable (GDP) and y is the explained variable (corporate income tax).

Time series analysis was used to forecast the ratio of corporate income tax to gross domestic product. The following general equation formula for a linear trend function was applied:

$$ui = a + b * t_i \quad (2)$$

$$\Sigma t \neq 0: an + b \Sigma ti = yi \Sigma ti + b \Sigma ti^2 = \Sigma tiyi \quad (3)$$

where n is the number of monitored years. t_i is the numbered monitored years. and y_i is the ratio of corporate income tax to GDP in percent.

Input data is from the period before 31 January 2020. So, the United Kingdom is also included.

The following abbreviations of the names of particular European countries are used in the presented research (Table 4).

To analyze the numerical series, the values for the period affected by a factor that did not influence the values reported in the other periods were discarded. In 2020, the coronavirus pandemic emerged as a significant factor. Particular states had different reactions to the coronavirus pandemic. Particular countries differed in the length and regimes of lockdowns and the amount of compensation. Therefore, the analysis did not include data for such an atypical period.

3. Results

Corporate income tax revenue is essential to the economic growth of any national economy. From the opposite point of view, the increasing share of tax revenues in GDP leads to poverty reduction in individual states. Therefore, according to the authors of this research,

Table 4. Abbreviations of particular EU countries included in the research

Abbreviation	EU country name
AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EC	Spain
EE	Estonia
EL	Greece
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Latvia
LU	Luxembourg
LV	Lithuania
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
UK	United Kingdom

it is beneficial to deal with the relationship between GDP and individual types of tax revenues. This was the primary motive for analyzing the dependence between the amount of corporate income tax revenue and GDP. The ratio of these two variables is shown in Table 5.

The number of evaluated countries is equal to 28.

The correlation coefficient was calculated as follows: (28 * 6 583 295.12 – 18 401.80 * 3 425.96) / √[(28 * 38 739 478.25 – 18 401.80²) * (28 * 1 252 611.23 –3 425.96)] = 0.9192.

The correlation coefficient was calculated according to the formula (1) given in the methodology. The value of the correlation coefficient was 0.9192. Since the correlation coefficient is in the range of 0.8 and above corresponds to a strong direct dependence, it can be stated that the collection of corporate income taxes strongly depends on GDP.

Furthermore, a prediction of the ratio of corporate income tax revenue to GDP in the Czech Republic for the next five years was compiled. Prediction is based on time series analysis. Table 6 represents columns of values with partial calculations.

Table 5. The degree of dependence of corporate income tax revenue on GDP (Ruprechtová, 2022)

Country	GDP	CIT	GDP^2	$(CIT)^2$	GDP*CIT
AT	447.72	124.42	200,453.20	15,480.34	55,705.32
BE	517.61	115.52	267,920.11	13,344.87	59,794.31
BG	68.56	1.58	4,700.47	2.50	108.32
CY	24.95	1.41	622.50	1.99	35.18
CZ	246.95	47.55	60,984.30	2,261.00	11,742.47
DE	3,863.34	439.18	14,925,395.96	192,879.07	1,696,701.66
DK	347.18	118.47	120,533.95	14,035.14	41,130.41
EE	31.04	8.54	963.48	72.93	265.08
EL	214.01	53.78	45,800.28	2,892.29	11,509.46
ES	1397.87	194.51	1,954,040.54	37,834.14	271,899.69
FI	269.65	55.55	72,711.12	3,085.80	14,979.06
FR	2,707.07	407.29	7,328,227.98	165,885.14	1,102,562.54
HR	60.75	1.4	3,690.56	1.96	85.05
HU	170.41	35.72	29,039.57	1,275.92	6,087.05
IE	384.94	72.75	148,178.80	5,292.56	28,004.39
IT	2,001.44	484	4,005,762.07	234,256.00	968,696.96
LT	35.05	5.38	1,228.50	28.94	188.57
LU	69.45	18.92	4,823.30	357.97	1,313.99
LV	53.64	10.85	2,877.25	117.72	581.99
MT	15.22	0.83	231.65	0.69	12.63
NL	902.36	218.6	814,253.57	47,785.96	197,255.90
PL	565.85	103.31	320,186.22	10,672.96	58,457.96
PT	236.41	54.51	55,889.69	2,971.34	12,886.71
RO	249.7	5.24	62,350.09	27.46	1,308.43
SE	528.93	117.99	279,766.94	13,921.64	62,408.45
SI	54.15	9.95	2,932.22	99.00	538.79
SK	106.55	20.42	11,352.90	416.98	2,175.75
UK	2831	698.29	8,014,561.00	487,608.92	1,976,858.99
Total sum	18,401.80	3,425.96	38,739,478.25	1,252,611.23	6,583,295.12

Note: CIT = corporate income tax

Table 6. Prediction of CIT yield to GDP ratio

ti	Year	Ratio of CIT to GDP in %	ti2	ti * ratio of CIT to GDP in %
1	2009	3.37	1	3.37
2	2010	3.21	4	6.42
3	2011	3.19	9	9.57
4	2012	3.31	16	13.24
5	2013	3.39	25	16.95
6	2014	3.5	36	21.00
7	2015	3.57	49	24.99
8	2016	3.73	64	29.84
9	2017	3.69	81	33.21
10	2018	3.62	100	36.20
11	2019	3.45	121	37.95
12	2020	3.71	144	44.48
13	2021	3.75	169	48.72
14	2022	3.79	196	53.05
15	2023	3.83	225	57.47
16	2024	3.87	256	61.96
136		56.98	1,496	498,42

Linear trend function equation (n =11):

11 * a + b * 136 = 56.98

a * 136 + b * 1496 = 498.42

ui = 3.21 + 0.04 * ti

- Forecast for 2020: 3.21 + 0.04 * 12 = 3.71
- Forecast for 2021: 3.21 + 0.04 * 13 = 3.75
- Forecast for 2022: 3.21 + 0.04 * 14 = 3.79
- Forecast for 2023: 3.21 + 0.04 * 15 = 3.83
- Forecast for 2024: 3.21 + 0.04 * 16 = 3.87

The prediction ratio of corporate income tax revenue to GDP was calculated using methodological formulas (2) and (3). If unexpected influences (e.g., the Covid-19 pandemic) are not taken into account, a steady increase in the ratio of corporate income tax to GDP can be predicted. Suppose it is based on the assumption that the rate of corporate income tax will not increase in the Czech Republic. In that case, the fulfillment of the prediction assumes that the government will continue with similar measures in the area of income tax until 2019 – primarily in the streamlining of tax collection, disclosure of tax evasion both domestically and internationally, and the consistent streamlining of tax controls. Furthermore, the set of DAC measures and ATAD directives can also play their role in fulfilling the prediction, which ultimately should contribute to higher tax collection and the prevention of tax fraud. In the event of stagnation or decline in GDP due to unexpected effects such as the Covid-19 pandemic, it can be expected that the CIT selection will similarly decrease due to the high dependence, which was calculated with a correlation coefficient of 0.9192.

4. Discussion

To analyze more closely the relationship of the ratio of corporate income tax to the gross domestic product, it is good to see its development over the years. For this purpose, the dependence between 2009 and 2019 was selected. The following Table 7 shows the ratio of the DPPO collection to GDP between the years 2009–2019 in percentage.

It is clear that between 2009 and 2019, the ratio of corporate income tax to GDP does not have a uniform trend. It has an upward trend in part of the monitored period. In the next part of the observed period, the trend decreases. This can be the result of many factors, e.g.:

- Changes in corporate income tax rates in particular EU countries. However, this factor is refuted by Fuest et al. (2022), who published interesting research on corporate tax revenues and declining tax rates. While corporate tax rates have declined in OECD countries in recent decades, corporate tax revenues relative to the gross domestic product have remained remarkably stable.
- Changes in other parameters of the tax system in particular EU countries.
- Other factors affecting business conditions in particular EU countries - for example, a study by the authors Andrejovská and Glova (2022) demonstrated the connection between corporate taxes and the level of investment in a given country.

Table 7. Ratio of CIT revenue to GDP in percentage – own processing based on (OECD, 2020; European Commission, 2022)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AT	1.63	1.87	1.99	2.00	2.15	2.11	2.23	2.35	2.46	2.67	2.67
BE	2.34	2.55	2.84	3.01	3.10	3.12	3.27	3.40	4.06	4.30	3.74
BG	2.11	1.78	1.77	1.72	1.90	2.01	2.18	2.23	2.30	2.25	2.30
CY	5.87	5.54	6.20	5.73	6.51	6.38	5.85	5.53	5.83	5.80	5.67
CZ	3.37	3.21	3.19	3.31	3.39	3.50	3.57	3.73	3.69	3.62	3.45
DE	1.33	1.50	1.69	1.72	1.77	1.73	1.72	1.97	2.03	2.14	2.01
DK	1.90	2.25	2.17	2.60	2.74	2.78	2.76	2.82	3.24	2.87	3.03
EE	1.80	1.30	1.20	1.40	1.72	1.71	2.04	1.68	1.53	2.00	1.81
ES	2.22	1.84	1.78	2.15	2.00	1.99	2.20	2.22	2.24	2.46	2.07
EL	2.51	2.53	2.07	1.09	1.15	1.88	2.14	2.49	1.95	2.16	..
FI	1.92	2.42	2.60	2.10	2.35	1.91	2.15	2.21	2.71	2.54	2.52
FR	1.43	2.34	2.63	2.58	2.64	2.31	2.08	2.03	2.32	2.10	2.24
HR	2.54	1.91	2.29	1.98	2.01	1.74	1.85	2.18	2.27	2.24	2.30
HU	2.19	1.21	1.19	1.28	1.34	1.60	1.73	2.28	1.99	1.34	0.72
IE	2.29	2.35	2.20	2.26	2.38	2.37	2.62	2.71	2.76	3.21	3.14
IT	2.37	2.28	2.17	2.38	2.55	2.17	2.03	2.13	2.08	1.87	1.94
LT	1.82	0.99	0.81	1.30	1.36	1.37	1.54	1.61	1.49	1.53	1.57
LU	5.61	5.75	4.98	5.12	4.76	4.30	4.41	4.48	5.11	6.32	5.92
LV	1.55	0.98	1.40	1.61	1.62	1.54	1.59	1.69	1.60	1.06	0.16
MT	5.83	5.56	5.32	5.71	5.99	5.86	5.86	6.15	6.11	5.27	5.44
NL	2.13	2.28	2.16	2.10	2.16	2.55	2.67	3.35	3.28	3.50	3.70
PL	2.24	1.95	2.02	2.08	1.77	1.75	1.84	1.84	1.93	2.09	2.23
PT	2.75	2.74	3.14	2.75	3.25	2.85	3.12	3.04	3.20	3.33	3.14
RO	2.27	2.05	2.29	1.88	2.02	2.12	2.35	2.22	2.01	2.01	2.10
SE	2.79	3.24	3.03	2.53	2.62	2.66	2.91	2.73	2.78	2.85	2.89
SI	1.80	1.84	1.65	1.23	1.19	1.41	1.46	1.60	1.78	1.94	2.12
SK	2.46	2.44	2.39	2.33	2.85	3.28	3.66	3.48	3.46	3.28	3.09
UK	2.51	2.85	2.57	2.53	2.56	2.85	2.84	2.82	2.65	2.63	2.49

Analogous to our research, Cheben (2022) et al. state that corporate income tax significantly affects total government tax revenue. Cheben et al. (2022) found a significant degree of dependence between selected evaluated variables in all groups in the monitored period. This dependence, especially between the total income and the tax base, as well as between the total income and corporate income tax, is an essential part of the economic result found in double-entry bookkeeping. However, this area will require a solution in subsequent research.

5. Conclusions

It can be stated that the highest corporate income tax rate is in Malta, which has a value of 35%. Conversely, on the other side of the ranking is Hungary, where the rate is only 9%. In none of the mentioned countries did the rate change in any way between 2018 and 2020.

The Czech Republic maintains the same constant rate – the rate is 19%. This rate is rather among the lower values within the EU. Great Britain has the highest corporate income tax revenue in billions of USD, while Latvia has the most insufficient tax revenue.

The volume of corporate income tax collection strongly depends on the size of the given economy. The highest ratio of corporate income tax revenue to GDP is in Luxembourg, where this value is 5.92%. Lithuania has the lowest value of the ratio, where a decreasing trend can be noted in the years 2009–2019 down to 0.16%.

Based on the results of the time series analysis, a steady increase in the ratio of corporate income tax revenue to GDP can be predicted in the Czech Republic to up to 3.87% over the next five years. The dependence of corporate income tax on GDP is direct and strong, so it can be stated that the collection of corporate income tax strongly depends on GDP.

According to the authors of this research, DAC I - DAC VI (Directive on Administrative Cooperation) determines the rules for the automatic exchange of tax information between European countries, and the ATAD (Anti Tax Avoidance Directive) is perceived positively by the professional public. For effective harmonization, which will bring comparable tax conditions for all EU states, these measures are not sufficient, and some are also too complex. According to the authors of this research, a significant step in ensuring equal tax conditions across all EU countries would be the introduction of a uniform methodology for determining the corporate income tax base. However, implementing a specific directive regulating the common tax base is not in sight. The Czech Republic has been dealing with a structural deficit for many years. The Czech Republic will likely have to adopt several austerity measures that will lead to a reduction in government expenditures.

Furthermore, it can be expected that the Czech Republic will make changes to the tax system leading to an increase in the income of some taxes. This will also increase the ratio of tax revenues to GDP. Therefore, the question of the shares of corporate income tax on GDP is a current topic. This topic can be addressed in further research.

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Can the Opening of China-European Railway Express Enhance Technical Sophistication of Export from Chinese Cities?

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Abstract: The China-Europe Class Train (CR-Express) is an effective channel connecting China with the international market, which provides new opportunities for the economic development of cities along the route. Using a multi-period DID model, this paper investigates the impact of the opening of the CR-Express on the export technical sophistication of cities and its impact mechanisms. The study shows that: the opening of the CR-Express has a positive promotion effect on export technical sophistication, and the basic findings remain robust after considering parallel trend tests and placebo tests; the mechanism test finds that the enhancement effect of the opening of the CR-Express on export technical sophistication is mainly realized through two paths: innovation-driven and industrial upgrading. The policy implication is how to increase the frequency and routes of the CR-Express in the future to radiate a larger range of enterprises and continuously optimize the transportation organization, and how to effectively dovetail China's innovation-advantaged industries facing transformation with the economic development gaps of the countries along the route, to achieve a "win-win" situation of innovation-driven, industrial upgrading in the opening cities and improved welfare levels in the countries along the route. The future development direction of CR-Express is to promote the continuous improvement of the technical sophistication of exports.

Keywords: CR-Express; export technical sophistication; double difference; innovation drive; industrial upgrading

JEL Classification: E61; F23; F36

1. Introduction

As China's "One Belt, One Road" international cooperation continues to grow, CR-Express has developed rapidly as a new vehicle and channel for international railway cargo transport cooperation. Since 2011, when the first "YUXINOU" train was launched in Chongqing, China, the number of CR-Express (CR-Express) has doubled every year. In recent years, China has put forward the issue of high-quality development, which includes not only the growth of trade scale but also the optimization and upgrading of trade structure. export technical sophistication, as an important indicator of the structure, technology, and production efficiency of export commodities, provides a good analytical tool for studying the international division of labor and the international competitiveness of a country or region.

At this critical period when China's economy is shifting from high growth to high-quality development, it is important for China to further improve export technical sophistication to transform China's foreign trade from "quantitative" growth to "qualitative" development and to realize its strategy of becoming a strong trading nation and transforming its economy. This is of great significance to China's strategy of becoming a strong trading nation and its economic transformation.

Numerous studies have shown that CR-Express has positively contributed to regional trade growth, industrial structure, and innovation efficiency in the cities where it operates. So, has the launch of CR-Express also increased the technological technical sophistication of cities' export? What are the mechanisms and pathways through which they work? This has not been systematically and critically discussed in the existing literature. Based on this, this paper systematically explains the mechanism of the impact of the operation of the CR-Express on export technical sophistication and constructs a corresponding econometric model to empirically examine the effect and mechanism of the operation of the CR-Express on the export technical sophistication, to provide a basis for China to effectively improve the export technical sophistication and achieve the goal of a strong trade country and high-quality economic development.

2. Influence Mechanisms and Theoretical Hypotheses

2.1 Effect of the Opening of the CR-Express on the Export Technical Sophistication

Since the opening of the first train, the CR-Express has shown a vigorous development trend. With the advantages of time efficiency and price to optimize the division of international transportation by sea, land, and air, it has greatly optimized the global production division of labor layout, while realizing the coastal development of Chinese mainland cities. On the one hand, due to the opening of the CR-Express, local import and export enterprises can obtain international market information more efficiently and constantly adjust their production strategies so that they can carry out the international division of labor with other countries through intermediate product trade, focus on their comparative advantages and continuously improve their production efficiency, thus improving the technical content of product production, which in turn leads to the improvement of the city's export technical sophistication. On the other hand, aside from maritime and air transportation, CR-Express provides a new means of organizing international land transport between China and Europe. Compared with traditional sea-rail transport, CR-Express can save 8-20% of the comprehensive logistics costs and has comparative advantages in meeting specific logistics needs such as high added value and strong timeliness. In addition, as a newly emerging and promising development, CR-Express is currently being heavily subsidized by the government to a large extent, which further reduces the direct logistics costs of CR-Express, and this can lead to significant increases in export technical sophistication (Liu, 2022).

In summary, the opening of the CR-Express will improve regional cooperation and exchange, reduce trade costs, assist opening cities in improving the technical content of their

export products, and enable the opening cities to transport their competitive high-value-added products with high logistics timeliness to the European market at lower logistics costs, enhancing their export technical sophistication. Based on these findings, the paper presents the following hypothesis.

H1: The CR-Express can significantly increase the export technical sophistication from the cities where it operates.

2.2. The Intermediary Role of the Innovation Drive in the Process of Promoting Export Technical Sophistication

The opening of the CR-Express may have a catalytic effect on the improvement of the regional innovation level. On the one hand, CR-Express opened to bring trade activities from different regions into a unified framework, promote cross-regional exchanges of knowledge and technology, and increase the level of regional technological innovation (Zhang et al., 2019). Moreover, by establishing direct links with developed Western economies via CR-Express, the exchange and cooperation of innovation factors and R&D resources can be made easier. This pathway offers new impetus to the technological and scientific upgrading of the source region. The "reverse transfer" pathway provides new impetus to the technological upgrading of the cargo source. (Ma, 2018). Meanwhile, at the other end of the CR-Express lies the developed economies of Europe, where many of the world's leading companies are located. By using CR-Express, Chinese companies can gain direct access to and effectively cooperate with technology leaders in developed countries, as well as bring their advanced management experience and technology to the opening cities at a lower cost.

The increase in innovation in a region can directly improve the competitiveness of local products in the international arena, increasing both the variety and the number of exported products, thereby increasing the technical sophistication of export (Gu et al., 2013). Import trade liberalization contributes significantly to the technical sophistication of export through the enhancement of corporate R&D innovation. (Sheng et al., 2017). The degree of autonomous innovation and R&D not only translates directly into production technology, but also enhances the manufacturing industry's ability to absorb technological spillovers from intermediate goods (Han, 2018), and technological innovation contributes to an increase in R&D investment, which in turn can lead to a greater degree of technological technical sophistication in export. (Arora et al, 2001). Additionally, it has been shown that companies with advanced technologies can reduce their R&D and learning costs, as well as achieve technological spillovers through investment and trade. Such technological spillovers contribute to the export of technical sophistication from technologically relatively backward countries or cities (Coe & Helpman, 1995; Wang et al., 2010).

In summary, the opening of the CR-Express can reduce the flow costs of innovation factors, bring advanced technology and experience to the opening city, and raise the level of science and technology innovation in the opening city. The improvement of the regional innovation level can in turn enhance the technical sophistication of the city's export through

channels such as R&D investment and technology spillover. Accordingly, this paper puts forward the following hypothesis.

H2: CR-Express can improve the export technical sophistication from the opening cities through technological innovation.

2.3. The Role of Industrial Upgrading as an Intermediary in the Process of Promoting Export Technical Sophistication

The opening of the CR-Express has greatly promoted the cross-regional flow of factors and realized regional industrial upgrading. On the one hand, the "transport cost effect" suggests that transport infrastructure enables the optimal allocation of factors by reducing transport costs, which creates the conditions for industrial upgrading. The opening of the CR-Express will enhance industrial upgrading through the optimization of the allocation of high-end factors (Zhang et al., 2019). The CR-Express enables Chinese enterprises to cooperate with enterprises in developed European countries "against the gradient", which realizes the two-way flow of production factors and achieves industrial upgrading by further optimizing the allocation of high-end factors in the cities where the CR-Express operates. On the other hand, CR-Express is divided into three major corridors: East, Central, and West, and each node city within the different corridors follows a similar route planning, policy orientation, and cargo source pattern. (Li, 2021). Enhancing the absorption and transformation capacity of factors between diffusion and inflow areas will increase incentives to take over overflowing production factors to transform them into local industrial upgrades.

The upgrading of industrial structure can generate industrial spillover effects from high-tech industries, which have a correlative effect on other industries, enabling other industries to improve their technological level and management efficiency and promoting the technological technical sophistication of regional export. (Li, 2011). Researchers have examined the role that industrial upgrading plays in increasing export technical sophistication from the perspective of penetration of high technology industries, arguing that this penetration effect can contribute to industrial institutional innovation, and institutional innovation, especially contractual systems and property rights protection systems, can affect the production costs of products and improve the production efficiency of urban industries, which in turn can affect the export structure of the trade sector and shift a country's export structure and production structure towards complex products, and increase the city's export technical sophistication. (Zhang, 2017)

In summary, the opening of CR-Express can promote industrial upgrading by reducing transport costs and optimizing the allocation of high-end factors. In turn, upgrading the industrial structure can improve the production efficiency of enterprises through the effects of industrial spillovers and the penetration of high-tech industries, which can enhance export technical sophistication. Accordingly, this paper puts forward the following hypothesis.

H3: CR-Express can improve the export technical sophistication from the opening cities through industrial upgrading.

3. Methodology

3.1. Construction of an Economic Model

Double difference (DID) is an important concept in empirical research and is widely used in policy evaluation studies, especially when evaluating progressive policy reforms that are demonstrating good fitting effects. To validate the train launch effect, it is necessary to compare the change in the cities in the study group before and after the CR-Express launch to evaluate the role of the CR-Express launch in enhancing export technical sophistication. Since this could also be a natural effect over time, it is necessary to introduce a change in the results of the cities in the control group before and after the train launch to eliminate the time effect within this group. We introduce a multi-temporal DID model to evaluate the effect of this shock, with the baseline econometric model being set as follows.

$$ets_{c,t} = \beta_0 + \beta_1 CRR_{c,t} + \beta_2 X_{c,t} + \gamma_c + v_t + \varepsilon_{c,t} \quad (1)$$

$$CRR_{c,t} = post_{c,t} \times treat_c \quad (2)$$

In model (1), the explanatory variable $ets_{c,t}$ is the export technical sophistication in the t year of city c. $treat_c$ is a policy dummy variable with a value of 1 for cities in the treatment group and a value of 0 for cities in the control group. $post_{c,t}$ is a time dummy variable that takes the value of 1 for the year in which a city starts the CR-Express and beyond, and 0 for the rest of the years. $X_{c,t}$ is a series of control variables. γ_c and v_t are city and year fixed effects, and $\varepsilon_{c,t}$ are the random disturbance terms of the model. Based on the characteristics of the study, the baseline regression section focuses on the β_1.

3.2. Variables and Data Sources

Explained Variable: Export technical sophistication

Current scholarly approaches to measuring export technical sophistication are generally based on the CA theory and the RCA index proposed by Hausmann et al. (2007). By using the ratio between a country's total export of a product to the total export of all countries exporting that product as the weight, this method produces a weighted average of all the technology-level indicators. Due to data limitations, this method is only suitable for measuring the export technical sophistication at the national level and cannot be broken down to the regions of a country. Xu and Lu (2009) improved this method by using GDP per capita and urban import/export data instead of national-level data, compensating for the shortcomings of Hausmann's (2007) method, and has been widely used in the academic community. Zhou et al. (2019) extends the application of export technical sophistication to the city level by utilizing industry-level data. Based on the above methodologies and the characteristics of the research subject, the measurement of the export technical sophistication of cities is carried out in two steps.

In the first step, the export technical sophistication of a high-tech product is determined using the methodology of Xu and Lu (2009).

$$PROD_k = \sum_{i=1}^{n} \frac{x_{ik}/x_i}{\sum_{i=1}^{n} x_{ik}/x_i} * y_i \quad (3)$$

In the formula, the x_{ik} denotes i country's export value of k product, x_i denotes the total export value of national products, and y_i denotes the i country's GNP per capita.

In the second step, referring to the measurement method proposed by Zhou et al. (2019), after obtaining the product-level data, it is summed to the city level with the product export value as the weight, thus obtaining the export technical sophistication for each Chinese city (ets).

$$ets_c = \sum_{k=1}^{n} \frac{x_{ck}}{x_c} * PROD_k \quad (4)$$

where x_{ck} denotes the *c* city's export value of *k* product, x_c is the total export value of city *c*, and ets_c is the export technical sophistication of city *c*. The logarithmic export technical sophistication value is taken as the explanatory variable.

Explanatory and Control Variables

Explanatory variable "The Opening of CR-Express (CRR)" is the interaction term between the policy dummy variable and the time dummy variable to indicate the launch of CR-Express in a city. Using the end of 2019 as the time point, cities that have launched CR-Express before then are used as the treatment group, otherwise, the control group is 0. treat If a city has launched a CR-Express by the end of each year, the value is 1 for that year, otherwise it is 0.

Control variables: (1) level of economic development of the city (lneco) (2) level of human capital (ln*h*um). (3) level of informatization (lninf). (4) Level of infrastructure development (fac). (5) Level of government intervention (gov).

Data Sources

In this paper, the data about 273 prefecture-level cities in China from 2009-2019 are used as a sample to study the impact of the opening of CR-Express on the technical complexity of exports. The relevant data are derived from the China City Statistical Yearbook, Wind database, and provincial statistical yearbooks. The results of descriptive statistics of each variable are shown below.

Table 1. Descriptive statistics of variables

Variables	Sample Size	Mean	Std. dev.	Min	Max
lnets	3,003	10.67	0.382	9.487	11.40
lneco	3,003	16.98	1.083	13.88	20.37
ln*h*um	3,003	5.851	0.686	3.137	8.047
lninf	3,003	6.557	0.778	2.480	10.32
fac	3,003	16.34	6.272	1.370	35.78
gov	3,003	0.229	0.0486	0.0750	0.418

4. Results

4.1. Baseline Regression

Table 2 shows the results of the baseline regression. The same city-fixed effects and time-fixed effects were controlled for in the regression process to exclude the effect of city-level time trends on the test results, and five control variables were gradually added to observe

the change in the coefficients of the explanatory variables. The results show that with the increasing number of control variables, the coefficients β_1 are always positive and reach statistical significance, implying that the enhancement effect of the CR-Express on the technological technical sophistication of city export is significant, even when controlling for individual factors, time effects, and various other factors.

Table 2. Baseline regression results

Variable name	(1) $lnets$	(2) $lnets$	(3) $lnets$	(4) $lnets$	(5) $lnets$	(6) $lnets$
CRR	0.302*** (17.63)	0.299*** (17.52)	0.294*** (17.19)	0.293*** (17.22)	0.290*** (16.97)	0.290*** (16.93)
lneco		0.013*** (2.90)	0.013*** (2.83)	0.012*** (2.66)	0.012*** (2.71)	0.012*** (2.66)
lnhum			0.158*** (4.11)	0.148*** (3.87)	0.147*** (3.84)	0.146*** (3.74)
lninf				-0.028*** (-3.57)	-0.029*** (-3.61)	-0.029*** (-3.58)
fac					-0.003** (-2.51)	-0.004** (-2.51)
gov						0.051 (0.34)
cons	10.188*** (1022.36)	9.956*** (123.61)	9.041*** (38.18)	9.290*** (37.71)	9.333*** (37.83)	9.336*** (37.82)
observations	3,003	3,003	3,003	3,003	3,003	3,003
R^2	0.464	0.465	0.391	0.410	0.406	0.407
Urban fixed effects	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES

Note: *, **, *** denote significance at the 1%, 5%, and 10% levels, respectively, with standard errors for clustering to the city level in parentheses.

4.2. Parallel Trend Test

The double difference method is based on the assumption of parallel trends. The trend of change in export technical sophistication in the treatment and control groups should remain parallel before the opening of the CR-Express. This paper uses the event analysis method to examine this assumption, and the model estimated is shown below.

$$lnets_{c,t} = \sum_{m=1}^{3} \lambda_m First_{c,t-m} + \sum_{n=0}^{3} \lambda_n First_{c,t+n} + \lambda_2 X_{c,t} + \lambda_3 \tau_t + v_t + \varepsilon_{c,t} \quad (5)$$

In model (3), $First_{c,t}$ is a dummy variable, which is taken to be 1 if a city is the first to open the CR-Express in year *t*, and 0 if the opposite is true. $First_{c,t-m}$ denotes the period *m* before the opening of city *c*. $First_{c,t+n}$ denotes the period *n* after the opening. The distinction between the antecedent and the consequent variables is used here to test the assumption of a parallel trend in the effect of the launch of the train.

According to Figure 1, the results indicate that the impact of CR-Express on the increase in the export of technical sophistication to the city was significant. As can be seen, the coefficient

estimates for the t < 0 intervals are not significant at bilateral 95% confidence intervals, indicating that the trend of change in export technical sophistication does not differ significantly between the experimental and control groups before the launch of the CR-Express. Further, the t > 0 interval coefficient estimates are significantly positive and increasing overall, indicating that the opening of the CR-Express positively influenced the export technical sophistication from Chinese cities and that the assumption of parallel trends is satisfied.

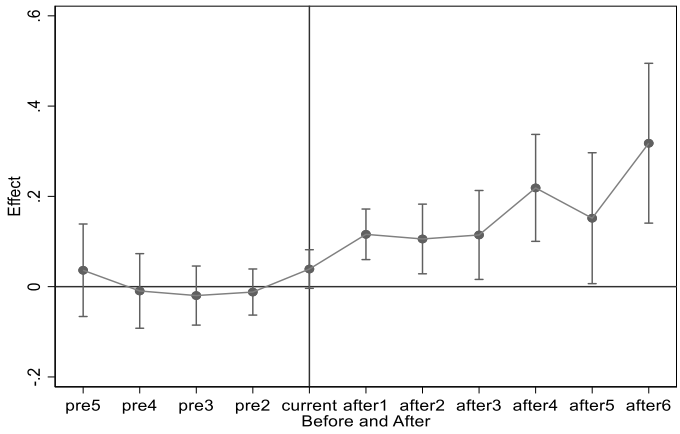

Figure 1. Parallel trend test

4.3. Placebo Test

To ensure that the increase in the technical sophistication of city export is solely caused by the opening of the CR-Express, this paper constructs a placebo test, in which the policy shock associated with the opening of the CR-Express is randomly selected among the treatment groups and then treated based on model (1). As a result, the reliability of the findings is measured by the probability of obtaining baseline results from a spurious experiment. The benchmark regression is conducted by randomly generating treatment groups from a sample of 273 prefecture-level cities, repeating this process 1,000 times, and plotting the distribution of spurious estimates of interaction term coefficients (Figure 2). The true regression results in Table 1 are on the right-hand side of the normal curve and do not intersect the normal curve, suggesting that other unobservable factors do not significantly impact the main estimates.

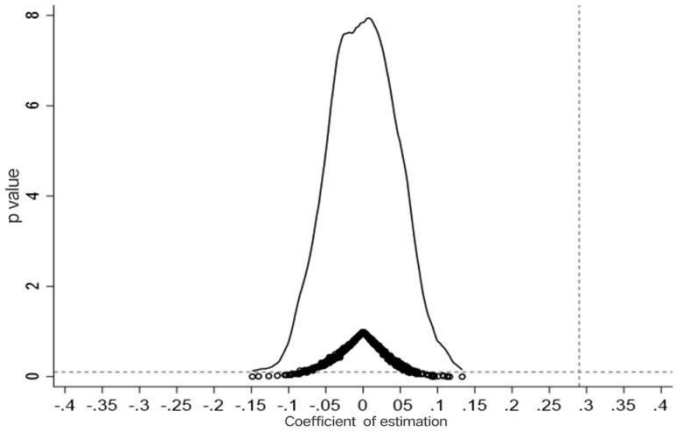

Figure 2. Placebo test

4.4. Mechanism Testing

Using the theoretical analysis presented in the previous paper, as well as the study of Wen et al. (2004), this paper proposes a mediation model.

$$IM_{c,t} = \beta_0 + \beta_1 CRR_{c,t} + \beta_2 X_{c,t} + \gamma_c + v_t + \varepsilon_{c,t} \quad (6)$$

$$lnets_{c,t} = \beta_0 + CRR_{c,t} + IM_{c,t} + \beta_2 X_{c,t} + \gamma_c + v_t + \varepsilon_{c,t} \quad (7)$$

In the above equation, IM is the mechanism variable, the other variables are set as in the baseline regression model, and the control variables are denoted by X. First, referring to the study by Bian et al. (2019), this paper measures the level of innovation in terms of the number of patents granted after logarithmization. Columns 1 and 2 of Table 3 show that the coefficients of the policy variables are significantly positive at the 1% level, indicating that the opening of the CR-Express significantly contributes to the level of regional innovation. At the same time, the coefficient on the policy dummy variable is significantly positive, suggesting that the launch of the CR-Express can improve the technological technical sophistication of the exporting cities by increasing the level of innovation and hence the export technical sophistication of the launching cities. Referring to Sheng Bin's (2005) study, this paper uses the share of tertiary industry value added to GDP as a proxy variable for regional industrial upgrading.Chyba! Nenalezen zdroj odkazů. The results in columns 3 and 4 of Table 4 show that the operation of the CR-Express significantly contributes to the upgrading of regional industries, suggesting that the CR-Express, as a bridge and link between China and the countries along its route, creates more opportunities and conditions for industrial upgrading, which in turn increases the export technical sophistication.

Table 3. Results of the analysis of the impact mechanism

Variables	Innovation driven		Industrial upgrading	
	patent (1)	***lnets*** (2)	***update*** (3)	***lnets*** (4)
CRR	0.224*** (15.21)	0.301*** (7.21)	0.041*** (4.21)	0.145*** (3.45)
paten = t		0.082*** (5.78)		
update				0.075** (3.11)
X	YES	YES	YES	YES
Province FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R^2	0.322	0.355	0.407	0.418

Note: *, **, *** denote significance at the 1%, 5%, and 10% levels, respectively, with standard errors for clustering to the city level in parentheses.

5. Conclusion

The launch of the China-Europe Classical Train (CR-Express) has strengthened the connectivity between China and European countries. In this context, this paper examines the effect of the CR-Express on the export technical sophistication from China's opening cities and investigates the mechanism by which the opening of the CR-Express increases the export

technical sophistication through both the "innovation level" and "industrial structure" factors. The findings are as follows.

Firstly, the opening of the CR-Express has a positive effect on the export technical sophistication, suggesting that the opening of the CR-Express is an important factor contributing to the increase in the export technical sophistication. This result passes both the parallel trend and placebo tests, which further supports its robustness. Secondly, the innovation drive mediates the relationship between the launch of CR-Express and the export technical sophistication, with the launch of CR-Express promoting the export technical sophistication in the launch cities through the improvement of regional innovation levels. Thirdly, the industrial structure mediates the relationship between the launch of the trains and the export technical sophistication, with the launch of the trains promoting the upgrading of the industrial structure to drive up the export technical sophistication. Therefore, we should increase the frequency and routes of the CR-Express to radiate a wider range of enterprises, continue to optimize the transport organization, vigorously expand the sources of return cargo, promote the intensive and efficient use of transport resources, and promote the continuous improvement of the export technical sophistication. On the other hand, we will continue to deepen our opening up to the outside world, adhere to the "going out" strategy, strengthen the consensus on cooperation with countries along the "Belt and Road", and, against the background of the continuous improvement of transport infrastructure such as the CR-Express, effectively match the industries with innovative advantages and facing transformation with the economic development gaps of countries along the route. In the context of the continuous improvement of the CR-Express and other transport infrastructures, China's innovative and transforming industries will be effectively dovetailed with the economic development gaps of the countries along the route, to achieve a "win-win" situation of opening up the city for innovation-driven and industrial upgrading and improving the welfare of the countries along the route.

Conflict of interest: none.

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Taxation and Accounting of Cryptocurrencies from The Point of View of the Czech And Slovak Republic

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Abstract: The submitted article deals with currently a very topical issue, which is cryptocurrencies. The goal of the article is to analyse cryptocurrencies from an accounting and tax point of view in the Czech and the Slovak Republic. Due to the complexity of all aspects, the paper is focused exclusively on personal income tax. The content of the article is also the characteristic of cryptocurrencies, comparison of differences between selected countries. Practical application of cryptocurrency taxation based on two model situations makes also a part of the article. The biggest difference between these two countries is that Slovakia has this issue processed legislatively. On the other hand, the Czech Republic does not. Another difference is the accounting capture of cryptocurrencies. In the Czech Republic, cryptocurrencies are accounted for inventories, while in Slovakia they are accounted for short-term financial assets. The last major difference is the point of view of transaction fees. In the Czech Republic, these are considered as tax-deductible costs compared to Slovakia. In both countries, operations with cryptocurrencies are taxed similarly according to the personal income tax, and at the same time the method of taxation depends on whether the income from this activity is received as part of a business or not.

Keywords: accounting; cryptocurrency; cryptocurrency taxation; taxes

JEL Classification: M21; M41; K34

1. Introduction

Cryptocurrencies are a very popular topic these days, both among investors, researchers and economic policy makers. The idea of some form of cryptocurrency dates back to 1989. However, the main milestone was 2008, when the digital currency Bitcoin was introduced (Černá & Hinke, 2022). Currently, cryptocurrencies are developing very quickly, they represent a very fast demand for all industries (Martincevic, Sesar, Buntak, & Miloloza, 2022) and raise a lot of legal questions that are in their early days (Goodell & Aste, 2019).

Cryptocurrency is a peer-to-peer online form of electronic cash that can be used to send payments between entities. These online payments do not go through the control system of financial institutions. Their value does not depend on any asset, country or company, but is based on a secure algorithm (Corbet, Lucey, Urquhart, & Yarovaya, 2019).

Cryptocurrencies can be defined as a decentralized payment system in which their ownership is expressed cryptographically. The Market, respectively, of the cryptocurrency system can be described as a system that serves to issue tokens that are used as a means of exchange (Lánský, 2020; Černá & Hinke, 2022). Cryptocurrencies can be acquired primarily

through specialized cryptocurrency exchange services or by mining them (Chervinski & Kreutz, 2019).

There is no trusted third party within cryptocurrency, but historical records of past cryptocurrency transfers back to their inception are required. This historical record is based on blockchain, which works on linking blocks in such a way that each block contains data about the previous block. Individual blocks then form a chain of digital records. Every participant in the cryptocurrency system has the same historical transactions at their disposal. Forging ownership is almost impossible, as this would require changing the previous blocks as well (Giudici, Milne, & Vinogradov, 2019). Adding more blocks of data is referred to as mining (Rueckert, 2019). The main difference between blockchain and a traditional ledger is decentralization. Traditional ledgers record transactions that are managed by centralized financial institutions, while blockchain is managed decentralized (Li & Whinston, 2019). Cryptocurrency ownership can basically only be proven cryptographically (Li & Whinston, 2019; Gregoriou, 2019).

Key features of cryptocurrencies include:

- Decentralization – the absence of a central authority that carries out administration,
- private transactions – subjects can remain anonymous (the existence of nicknames),
- no warranty – no legal protection or liability,
- blockchain – connectedness of previous data,
- unregulated – no central authority controls cryptocurrencies (Juškaitė & Gudelytė-Žilinskienė, 2022).

Cryptocurrencies are considered an alternative type of asset, although there are a variety of opinions on their classification. Investing in cryptocurrencies, however, poses a high risk, especially with regard to their price development and security (Ballis & Drakos, 2021). There are several thousand types of digital currencies in the cryptocurrency market. These currencies differ in security, privacy or financial influence (Li & Whinston, 2019). If there is growth in the market or market capitalization, the number of cryptocurrencies may increase in the following periods (Ballis & Drakos, 2021).

Important factories for a successful cryptocurrency include:

- Resistance to cyber attacks,
- ease of use – clarity, simplicity and ease for users,
- providing anonymity,
- impossibility of use for activities involving criminal activity,
- property of money (Bieliková, Hakalová, Pšenková, & Hlaváček, 2020).

According to Rejeb, Rejeb, and Keogh (2021), ownership of cryptocurrencies brings high efficiency, high security and privacy, the possibility of diversification and low transaction costs. More about cryptocurrencies, for example, in (Enoksen, Landsnes, Lucivjanska, & Molnar, 2020) or (Grobys & Sapkota, 2019).

There are several thousand varieties in the cryptocurrency market that differ from each other (Klose, 2022). Figure 1 uses the most valuable cryptocurrencies according to their market capitalization.

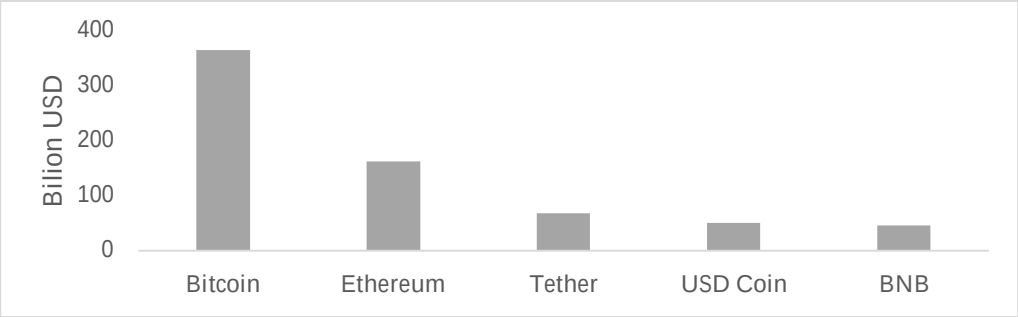

Figure 1. Selected types of cryptocurrencies according to their market capitalization. Own processing based on Coinmarketcap (2022).

There are different views on cryptocurrencies in different states. In Europe, Germany is the first to define cryptocurrencies in law. Germany defined cryptocurrency like type of financial instrument in private sector. So, the tax is counted from the cryptocurrency. The Great Britain discuss about cryptocurrency and their use in taxes. In USA, cryptocurrency is mostly used in private sector, for salary payments and in services (e.g. payments in restaurants). ATMs allows activities between cryptocurrency and dollars. Cryptocurrencies are mostly used in Japan. Japan registered cryptocurrency like regular currency in 2017. The People's Republic of China has restrictions of the cryptocurrency since 2018. Because of electricity costs from mining cryptocurrency, financial risks and money laundering (Inshyn, Mohlilveskyj, & Drozd, 2018). These are some selected countries that are considered to be the world's largest economies.

2. Methodology

In the paper, the methods of analysis and comparison were mainly applied. For clarity and understanding of the issue of taxation of cryptocurrencies, several model situations are established.

Table 1 shows model situations No. 1 - 4 for the application of the effects of the weighted arithmetic average method and the First in First Out method on the tax base. These methods are used to determine tax expenses. Table 1 shows the situation when a natural person made a total of 4 transactions related to cryptocurrencies in 2022. These transactions are only associated with the purchase and sale of cryptocurrency. The number of units in the given months represents the specific number of cryptocurrencies bought and sold. For currency conversion, the exchange rate according to the Financial Administration (2023) is set at 24,54 CZK/EUR as of the date of writing the article. This course type was used to simplify the model assumptions.

Table 1. Model situations No. 1–4

Month	Number of units	Purchase in EUR	Purchase in CZK	Sale in EUR	Sale in CZK
January	3	2,400	58,896		
May	2	800	19,632		
July	5	3,400	83,436		
December	6			4,800	117,792

3. Results

This sub-chapter will be devoted to the accounting and tax capture of cryptocurrencies in the Czech and Slovak Republics. In principle, the taxation of cryptocurrencies only applies to personal income tax, corporate income tax and value added tax. Due to the complexity of all aspects, the post is focused exclusively on personal income tax.

3.1. Accounting and Tax Recording of Cryptocurrencies in the Czech Republic

In the Czech Republic, there is no legislative regulation directly in the field of cryptocurrencies. The issue of taxation and accounting of cryptocurrencies is primarily regulated by Act No. 561/1993 Coll., on Accounting and implementing Decree No. 500/2002 Coll. Furthermore, on 15 May 2018, the Ministry of Finance of the Czech Republic published an opinion on the accounting and presentation of digital currency.

From the tax point of view, cryptocurrencies are considered intangible, movable and fungible, and at the same time they are not cash or non-cash money or any form of investment instruments. The subject of income tax is the income received when selling cryptocurrency for legal (fiat) currency, as well as income obtained by exchanging cryptocurrency for goods or income obtained by exchanging cryptocurrency for cryptocurrency. In the first situation, taxable income arises at the moment the money is received. In the case of the second option, taxable income occurs the moment the transaction is recorded on the blockchain. Cryptocurrencies acquired through exchange are valued at the price that would be received when selling a similar asset or service provided.

In the case of ownership of cryptocurrency that is obtained through mining, from the point of view of taxes, the procedure is similar to that of self-production, i.e. that there is no taxable income during the creation of cryptocurrency until the moment of its sale. Assets acquired in this way are valued at their own costs according to the Accounting Act and decree, i.e. at direct costs and directly attributable indirect costs. In the case of the purchase and sale of goods for cryptocurrency, this is an exchange, or the purchase and sale of an item. Income from a given shift is treated as income in the year in which the income is earned. A tax-deductible expense is the value of cryptocurrency recorded in accounting.

The taxation procedure basically depends on whether it is a one-time or regular income or whether the cryptocurrency is classified as a business or not. In addition, cryptocurrencies can be used to pay the employee's net salary (in this case, the procedure is according to § 6), they can also be used to pay interest on a loan that is negotiated in cryptocurrencies (§ 8) or they can be used to pay rent (§ 9). However, from the point of view of personal income tax, cryptocurrency transactions are primarily taxed as income from self-employment (§ 7) or as other income according (§ 10).

In the case where the taxpayer conducts transactions with cryptocurrencies regularly, in his own name and for the purpose of making a profit, the income from this activity will fall under § 7. In the case where the taxpayer owns a trade license, he proceeds according to § 7/1/b), if he does not own the license, thus proceeding according to § 7/1/c). Against income, the taxpayer can claim either actual expenses or expenses as a % of income. Actual expenses include the input value of cryptocurrencies, or other expenses (transaction fees, etc.). If he

decides not to apply actual expenses, he can apply expenses as a % of income in the amount of 60% or 40% when determining the tax base.

In the case of rental income for property that is included in commercial property, the procedure is according to § 7/2/b), otherwise according to § 9/1/a). In all other cases, the procedure is according to § 10/1/b/c), according to which the possible loss is not taken into account. The exemption from taxation according to § 10/3/a) does not apply to cryptocurrencies, under which income up to CZK 30,000 is exempt. Nor can the exemption according to § 4/1/w), x) be applied to cryptocurrencies. These paragraphs (under the Act No. 586/1992 Sb., on Income Tax) state that the sale of securities is exempt if this income does not exceed the amount of CZK 100,000 per year or the period between acquisition and sale is more than 3 years.

From an accounting point of view, it is recommended that cryptocurrencies be recorded as a special type of inventories in accounting.

The acquisition of cryptocurrencies by purchase is valued at the acquisition price, which consists of the acquisition price and ancillary costs (for example, transaction costs to the cryptocurrency trader). The acquisition of cryptocurrencies by mining is valued at the own costs that were incurred for their creation (for example, energy consumption, employee wages, etc.). Appreciation of depreciation of cryptocurrencies in a situation where multiple purchases were made during the year, two depreciation valuation methods can be used as an expense, namely the weighted arithmetic average or the FIFO method. At the end of the balance sheet day, if the accounting entity discovers that the market value of cryptocurrencies is lower than the value in the accounting, an adjustment item is created. The creation of a correction item represents a non-taxable expense for the company. Cryptocurrencies are not valued at fair value at the balance sheet date (Financial Administration, 2022).

3.2. Accounting and Tax Recording of Cryptocurrencies in the Slovak Republic

From the point of view of legislation, Slovakia has a more sophisticated cryptocurrency issue. In 2018, Act No. 213/2018 Z. Z., on insurance tax and the amendment and addition of certain laws, implemented the rules for the accounting and taxation of cryptocurrencies, in which transactions with cryptocurrencies that are subject to tax are directly listed. Furthermore, in 2018, the Ministry of Finance of the Slovak Republic, as well as the Czech Republic, issued a methodological instruction on the procedure for the taxation of virtual currencies, which also includes the definition of cryptocurrencies. Cryptocurrencies, just like in the Czech Republic, do not have the legal status of currency or funds, but it is possible to use them as a means of payment.

According to the Income Tax Act, income from the sale of cryptocurrencies is taxable income that is subject to tax. Any exchange of cryptocurrency, whether for property, services or other cryptocurrency, is considered a sale. Income from cryptocurrencies is reported in the period in which the income from the cryptocurrency occurs. Income from cryptocurrency mining is reported in the period in which the sale of the given cryptocurrency takes place.

As in the Czech Republic, the problematic part is the taxation of income from cryptocurrencies from the point of view of continuous or occasional activity.

From the point of view of the Income Tax Act, the mining of cryptocurrencies itself is similar to that in the Czech Republic, namely the mining of cryptocurrencies does not constitute taxable income. Taxation will only occur in the case of the sale of cryptocurrency. Unlike the Czech Republic, however, in the case of cryptocurrency mining, it is possible to proceed within the framework of business, but also within the framework of non-business activities.

A taxpayer who does not have cryptocurrencies included in business assets or does not use them for business activities, income from the sale of cryptocurrency falls under other income according to § 8. To determine the tax, it is possible to reduce income by expenses that relate to the given area. If expenses are greater than income, the difference is not taken into account. This procedure is the same as in the Czech Republic.

In the case of a bribe exchange of cryptocurrency for legal currency, the received funds are taxable income. In case of conversion of cryptocurrency for property, service or other cryptocurrency, this non-monetary income is valued at fair value (for example, market price).

The entry price in the case of a cryptocurrency that is acquired for a fee is the purchase price. In the event that a cryptocurrency is purchased for another cryptocurrency, the input price is its real value. Tax-deductible costs are the entry price of cryptocurrency in the period in which the sale takes place, up to the amount of income from their sale. You can never make a loss from cryptocurrency transactions.

Cryptocurrency transactions are not exempt from tax, just like in the Czech Republic.

For the purposes of the Income Tax Act, cryptocurrencies are valued at fair value if the cryptocurrency is acquired for another, and at cost if the cryptocurrency is acquired for consideration.

From the point of view of the Accounting Act, cryptocurrency is considered a short-term financial asset other than cash, which is a different view compared to the Czech Republic. In the case of a paid acquisition of cryptocurrencies, they are considered immediately as a short-term financial asset other than cash and are valued using fair value. In the case of cryptocurrencies that are obtained through mining, they are recorded in the off-balance sheet. At the moment of use of cryptocurrency, it is valued through real value.

Any increases or decreases are charged to financial income or financial costs. When valuing cryptocurrency depreciation, it is possible to use either the weighted arithmetic average or the FIFO method. There is no obligation to revalue cryptocurrencies to fair value at the end of the balance sheet day (Financial Administration, 2018; Act no. 595/2003).

3.3. Determination of Tax Expenditure

From a practical point of view, there may be a problem with determining the purchase price in a cryptocurrency transaction. When valuing cryptocurrency depreciation, it is possible to use either the weighted arithmetic average or the FIFO method. To quantify the differences between these methods, model situation No. 1 is used.

Both the VAP method and the FIFO method are used to value the distribution of bitcoin, the results of which can be viewed in Table 2 and Table 3.

Table 2. Calculation of expenses using the method VAP and FIFO in CZK

Method	Calculation expenses	Results in CZK
VAP	$\frac{(58{,}896 + 19{,}632 + 83{,}436)}{10} \cdot 6$	97,178.4
FIFO	$58{,}896 + 19{,}632 + x$ $X = \frac{83{,}436}{5} \cdot 1 = 16{,}687.2$	95,215.2

Table 3. Calculation of expenses using the method VAP and FIFO in EUR

Method	Calculation expenses	Results in EUR
VAP	$\frac{(2{,}400 + 800 + 3{,}400)}{10} \cdot 6$	3,960
FIFO	$2{,}400 + 800 + x$ $X = \frac{3{,}400}{5} \cdot 1 = 680$	3,880

According to the results of both methods, the VAP method is optimal for tax purposes in the case of this model situation, but the chosen procedure always depends on the given circumstances. In this case, the basis of tax in the Czech Republic is the difference between income and expenses. The value of income amounts to CZK 117,792, and based on the chosen valuation method, expenses amount to CZK 97,178.4. Similarly, in Slovakia, income is 4,800 EUR and expenses are 3,960 EUR.

4. Discussion and Conclusions

This article dealt with the issue of cryptocurrencies mainly from an accounting and tax point of view in the Czech Republic and the Slovak Republic. The purpose of the article was also the characteristic of cryptocurrencies and comparison of differences between selected countries.

The Slovak Republic, unlike the Czech Republic, has a detailed legislative regulation of the issue of cryptocurrencies, in which cryptocurrencies are considered as virtual currency. The Czech Republic has issued only recommended methodological guidelines for the field of cryptocurrencies, through which cryptocurrencies are considered an intangible movable property. In the Czech Republic, cryptocurrencies are accounted for inventories of its kind, while in Slovakia, cryptocurrencies are accounted for a short-term financial asset. There is also a difference in the area of transaction fees, which are tax deductible in the Czech Republic, while not in Slovakia.

The subject of personal income tax in both countries is the income derived from the sale of cryptocurrencies for legal tender, non-monetary income from their exchange for goods and for other exchange and income from the sale of mined cryptocurrency. Cryptocurrency mining itself is viewed very similarly in both countries. Mining itself is not subject to tax, but only its subsequent sale is. In the framework of cryptocurrency trading, only the profit from the trade is subject to tax. Such profit is either treated as business profit or as other income. At the same time, operations with cryptocurrencies cannot be exempted from income tax under any conditions.

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Factors of Success in Electronic Public Procurement as Part of E-government

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Abstract: Key factors in the functioning of the public administration system is increasing the efficiency of electronic public procurement as one of the components of e-government. Efficiency in public procurement is often assessed from only one point of view, and that is price, or of the difference between the expected and competitive price. However, this view is insufficient, as a number of other factors enter into the entire public procurement process, which have a significant impact on the price. It is also important to examine the price not only from the point of view of the contractor, but also of the applicant. This paper deals with the investigation of factors, that have influence on the price in public procurement in Slovakia from the point of view of the applicant. The research was carried out on the basis of the methodology of the planned experiment, which is referred as Design of Experiment and within this method we used a partial (one-eighth) factorial design of the experiment. Through the statistical processing of the obtained data, we identified three factors, that significantly influenced the success of the applicant for a public contract in the procurement process of a specific type of goods.

Keywords: public administration; public procurement; price; experiment; factors

JEL Classification: H41; H57; H83

1. Introduction

One of the areas of public finance, that attracts more and more public attention is the public procurement process. This is mainly, because the procurement of goods and services, or construction works by the public sector uses resources, that come largely from state budget or local budgets, the main contributors of which are mainly citizens. The field of public procurement in Slovakia was and is problematic from many points of view. This is mainly due to constantly changing legislation, a high level of bureaucracy and corruption, an insufficient level of control, a low level of efficiency, a conflict of interests, or a small circle of suppliers involved (Bednárová et al., 2020).

The public procurement process should generally meet the principles of transparency, openness and professionalism in every country. In many cases, this is not the case, and the redistribution of public finances becomes non-transparent and ineffective. Lack of transparency and inefficiency is not prevented, although developing countries of Central and Eastern Europe have significantly increased the volume of the public procurement market in recent years. It is estimated, that public procurement in these countries represents more than 10% of GDP (Nemec et al., 2020).

As already mentioned, despite the fact, that the size of the public procurement market has been growing in recent years, not enough attention is currently paid to measuring the economic efficiency of this processes. The above-mentioned facts are also confirmed by many studies. Grega (2018) pointed out in his study, that the most important factor, that determines the efficiency of public procurement in Slovakia is excessive bureaucracy. The second most frequent factor was the constant change of the relevant legislation, and the third factor was the lack of ethics and morals on the part of the contracting authorities. The fourth most important factor was corruption and the efficiency of public procurement in Slovakia was the fifth most important factor, from the point of view of the contracting authorities (Grega, 2018).

When solving the issue in question, it is appropriate to first analyze the concept of efficiency itself and then address it in the context of public procurement. Samuelson and Nordhaus (1992) define the term efficiency as a state, in which there is no waste. According to Afonso et al. (2006), efficiency is more difficult exactly and objectively to define, than to identify. When examining the concept of efficiency, it is also necessary to distinguish between allocative and technical efficiency. Stiglitz (2011) defined allocative efficiency as the optimal allocation of scarce resources in the economy, and according to him, achieving this efficiency belongs to one of the four basic economic functions of the state, which also has a microeconomic character. According to Kerstens (1999), allocative efficiency mainly requires setting the goals, that we want to achieve. Achieving allocative efficiency therefore means the use of resources in the economy, in which the maximum possible benefit occurs. Allocative efficiency is mainly concerned with whether the use of resources achieves a predetermined state. On the other hand, technical efficiency is defined by Kerstens (1999) as production at the limit of production possibilities, i.e. scarce resources are used to the maximum extent possible.

One of the other suitable tools for evaluating the economy and, to a certain extent, the efficiency of public procurement is benchmarking, which can be used for internal (prices of the same goods, services and construction works within the organization) or external comparison (with market prices or with the prices of other contractors) and ultimately it can increase the efficiency of public procurement (Chamberland, 2005; Triantafillou, 2007; Raymond, 2008). The resulting benefit of the systematic use of benchmarking in the evaluation of the public procurement is the prevention of collusion (Langr, 2020), the increase of ,,competitiveness" between public contracting authorities, a better reporting ability than in the traditional comparison with the expected value of the contract, and increased transparency of the evaluation of the effectiveness of public procurement. The disadvantage is, that benchmarking in public procurement can only be used for comparable and easily measurable goods, it also does not take into account the volume of purchased goods (economies of scale), quality, post-contractual behavior of the supplier, and last but not least, its reporting ability over time is limited by the level of inflation.

In the context of the efficiency of public procurement, we most often encounter the fact, that efficiency is perceived as the so-called saving, which is quantified by the difference between the expected value of the contract and the final price, while simultaneously monitoring the factors affecting the saving. We can state, that a number of already conducted studies focus on examining the price only from the point of view of the public

contracting authority and the determinants, that influence it, but only a few of them, examine the price from another point of view, i.e. from the applicants. We focused on this issue in this paper. For this reason, the main goal of the submitted paper is the identification of factors, that have a relevant influence on the price in public procurement in Slovakia from the applicant point of view.

2. Methodology

In order to achieve the main goal of the presented contribution, we used the method of planned experiment, which is referred to as Design of Experiments (DOE), for the statistical processing of the obtained data.

Experimentation has been the main way mankind has come to knowledge since time immemorial. A small child makes sure, that the stove is hot by making an attempt - grabbing it. He performs some activity, which we call an experiment, and upon the result of the experiment he becomes familiar with a new fact. Overall, experimentation is action and reaction. In practice, ,,trial-and-error" experimentation is often performed. These are experiments: ,,I'll try and see if it's good or bad". The problem with this experimentation is the unstable result, which usually does not provide true insight. Experiments are usually very expensive and knowledge is paid a lot. And that's why it's good, if we consider in advance what we're going to do, how we're going to do the experiment, i.e. we will develop a plan. Therefore, with the given approach, we speak of a planned experiment (Turisová & Pačaiová, 2017).

We perceive the term experiment itself in general as a system of attempts, which are ideally arranged in a planned experiment. A crucial goal of DOE is to find out the links and relationships between the variables of the process, that we are investigating. So here we have a method capable of perceiving even a complex and difficult-to-understand process as an element for which, although we cannot find a suitable mathematical model, we can empirically estimate how its inputs affect the outputs. The aim of the experiment is to determine, which explanatory variables - factors (input, influencing quantities) influence the explained variables - responses (monitored, output quantities). Another task is to find the levels of the factors, with the help of which we would work towards the optimum (the so-called maximum and minimum) of the monitored quantity (Veber et al., 2007).

DOE is a method of planning experiments, that is generally used to test and optimize processes, products or services. It can be used to obtain more information about the behavior of the process or product under different conditions. It allows to systematically plan and select factors, that can be further analyzed based on data obtained from the process running under changed conditions. Generally, experiments are done to find factors of possible influence or to optimize some effects. For optimization, data from the experiment is used to create an assumed model, which is an equation designed to describe the functional dependence of the output characteristic on the input factors. The method consists in carrying out several experiments of the process, in which it is determined, what the output is for different combinations of input factors. The obtained values are processed into a mathematical expression of dependence, which can be used in process control, i.e. for setting factors to achieve the required value of the output characteristic or to achieve its maximum or minimum (Kučerová, 2012).

To construct the model, it is necessary to have measured quantities obtained by tracking without targeted intervention, the so-called planned experiment. The planned experiment creates the conditions for the smallest possible range of attempts, but in such a way that the volume and form of data, but mainly the quality of information, is as large as possible (Woods & Lewis, 2015). For factors, we create ideal levels within permissible intervals. The requirement for efficiency is mainly applied in experiments with multiple factors.

The mathematical model of the experiment belongs to the basic concepts of the theory of the experiment. The model of the experiment is in accordance with physical ideas and includes a description of the given state of the object, that is being measured, as well as a description of directly or indirectly measurable quantities, that are measured and determined by experimentation, respectively the state of the object, that is the object of interest (Antony, 2014). Thanks to the DOE method, we can find out as much information as possible with the smallest possible scope of the experiment. Using input factors (denoted as x_1, x_2, ..., x_n) we understand their influence on outputs (denoted as y_1, y_2, ..., y_m) (Mason et al., 2003). In this way, correlations between the inputs of the process and its outputs are determined. A functional relationship is mathematically constructed (Montgomery, 2001):

$$y = f(x_1, x_2, \dots, x_n) + \varepsilon \quad (1)$$

where ε is the error of the experiment, i.e. deviation of a given experiment. The error of the experiment probably describes the non-existent exact functional relationship between y and x_1, x_2, ..., x_n. When designing experiments using DOE, we seek such inputs, that the method represents a robust tool. A tool, that serves to understand processes and research factors - their parameters, that significantly affect it. So it sorts the factors into important and less important, according to the surrounding conditions. This is how we get information that expresses the mutual influence of responses y_1, y_2, ..., y_m by factors x_1, x_2, ..., x_n (Montgomery, 2001).

Due to the fact, that the planned experiment method offers several alternatives for its application, we decided to use the factorial design of the experiment. The reason for choosing this type of experiment was mainly the fact, that it can identify statistically significant factors when examining several factors at once, with several levels. Since we considered several factors at two levels (lower and upper level), we applied a multifactorial two-level experiment. As a response, we chose the unit price in public procurement. Individual factors were chosen based on the analysis of already conducted studies, which described the factors probably influencing the price. By synthesizing the conducted studies and at our own discretion, we finally chose eight factors, with the aim of examining their influence on the chosen response. The factors investigated were:

1. Type of institution – type of contractor depending on its source of financing. The upper level was made up of procurers, who are financed from the state budget. The lower level consisted of procurers financed from local budgets, i.e. from the budgets of cities and municipalities.
2. Area – examination of whether the procurers comes from the same or a different territorial region. We considered the regions in the context of eastern Slovakia, western

Slovakia, central Slovakia and Bratislava. The upper level was represented by applicants and procurers coming from the same regions and the lower level from different regions.

3. Number of pieces – the total number of pieces of procured goods within one order. The upper border was made up of 2 or more pieces, while the lower border was made up of only one piece.
4. Number of applicants – the total number of applicants, who submitted price offers and participated in the contract. The upper limit was three or more applicants and the lower limit was 1 to 2 applicants.
5. Technical parameter no. 1 – the size of the hard disk (HDD). The upper limit was represented by a 1,000 GB HDD and the lower limit was 500 GB.
6. Technical parameter no. 2 – type of processor. The upper limit was the i5 type processor and the lower limit was the i3 type processor.
7. Number of days of fulfillment – the total number of days required for the delivery of the selected goods. Five or more days represented the upper limit and one to four days represented the lower limit of the given factor.
8. Savings – the difference between the estimated contract price and the competitive price. The upper limit was a saving, that was higher than five Euros, and the lower limit was a saving lower than five Euros.

Since the number of measurements in a full factorial two-level experiment would mean up to 256 measurements, based on the 2^k relationship, we decided to finally apply a partial – one-eighth factorial design of the experiment to simplify the conditions. The notation for this design of experiment is of the form 2^{k-p}, where ,,k" represents the number of factors and ½p represents part of the full 2^k factorial experiment. While it is true, that the number of attempts of a partial experiment must not be lower, than the number of factors, i.e. $n \geq k$ (Montgomery, 2001). Finally, a partial (one-eighth – 2^{8-3}) factorial design of the experiment was implemented with 32 measurements. As part of the experiment, we investigated the effects of individual factors on the change in response that the factor causes if its level changes from – 1 (lower level) to + 1 (upper level). The effect of the factors on the response is subsequently determined as the difference of the response averages for the factor at the upper level $\bar{y}_{A+}$ and for the factor at the lower level $\bar{y}_{A-}$. This can be written as (Montgomery, 2001):

$$effect\ of\ factor\ A = \bar{y}_{A+} - \bar{y}_{A-} = \frac{1}{2n}\,[ab + a - b - (1)] \tag{2}$$

Analogously, the effect of factor B is calculated as follows (Montgomery, 2001):

$$effect\ of\ factor\ B = \bar{y}_{B+} - \bar{y}_{B-} = \frac{1}{2n}\,[ab + b - a - (1)] \tag{3}$$

In addition to the main effects, we can determine the presence of their mutual interactions among the individual factors. We determine the effect of the interaction of factors AB as the average value of the difference between the effect A on the upper level B and the effect A on the lower level B, which has the form (Montgomery, 2001):

$$effect\ of\ interaction\ AB = \frac{1}{2n}\,[ab + (1) - a - b] \tag{4}$$

The result of the experiment is a regression model, that predicts the magnitude of the response at a different combination of individual factors at their best level. The regression model for a planned experiment with factors observed at two levels usually has the form (Montgomery, 2001):

$$y = \beta_0 + \beta_1 A + \beta_2 B + \cdots + \beta_{12} AB + \beta_{13} AC + \cdots + \varepsilon \quad (5)$$

where:

y – response value,

β_0 – average response value,

β_1, β_2 – values of regression coefficients,

β_{12}, β_{13} – regression coefficients for interactions between factors,

A, B, C – factors of the experiment,

ε – random error

Based on the above facts, the program generated an experiment plan, which consisted of random combinations of the values of the selected factors within 32 measurements. The created factor plan was used to identify such orders that met the combinations of values of the selected factors. In the next step, we used market research to find out the prices of the subject type of goods at a specific time at selected public contracting authorities on the basis of a factor plan. Through market research, we simulated the conditions of public procurement.

The source of data for the execution of the planned experiment was public procurement in Slovakia for the period 2019 to 2021, carried out through the Electronic Contracting System, one of the tools of which is the electronic marketplace. Since a large number of procurements are carried out within the electronic marketplace, we focused only on the procurement of selected types of goods, i.e. computing technology (ICT), specifically laptops. The reason for choosing this area of data was the fact, that electronic public procurement in Slovakia provides publicly available data and also, that computer technology is one of the most frequently procured goods in the electronic marketplace.

Subsequently, we focused only on public procurement of computing technology for the years 2019 to 2021, in which computing technology was procured in the form of portable computers, that met the technical parameter of HDD 500 GB and 1,000 GB and processor i3 and i5. After that, we collected available information about the contracts implemented in this way regarding the competitive price, expected price, contracting authority, bidders, time of fulfillment, auction options, and the like. The source data set consisted of a total of 420 procurements of the subject pre-specified goods.

3. Results

After creating the research sample, determining the response and defining the individual research factors, an experiment plan containing random combinations of the values of the selected factors within 32 measurements was created. We analyzed the results of individual measurements through the use of several statistical-mathematical methods, which we describe in the next part of the paper.

In the first step, after conducting the experiment, we proceeded to identify the factors, that significantly affect the response through Pareto analysis. In this case, the Pareto analysis does not show the classically well-known Pareto diagram, since the x-axis is replaced by the y-axis. This analysis separates significant factors from those, that are only the result of experimental noise based on the constructed factorial design. In addition, the analysis is performed for all factors and for all mutual interactions of these factors. Monitored p-values determine, which factor and interaction of factors is statistically significant in the model, respectively insignificant. With the help of regression analysis, the least significant interactions and factors are successively eliminated, starting with the highest value until all p-values of the model are ≤ 0.05 (Sabová, 2015).

The alpha significance level was chosen at the level of 0.05, while the absolute values of the effects are on Figure 1 shown on the x-axis and individual factors including their combinations on the y-axis. Resulting from graph no. 1 we can state, that we consider factors exceeding the alpha significance level on the right to be statistically significant factors. Conversely, all other factors located to the left of the vertical line showing the alpha significance level are below the chosen significance threshold, i.e. we consider them to be statistically insignificant. The conclusion of this investigation is the knowledge, that a total of four factors have a statistically significant effect on the competitive price in the public procurement process, based on the conducted experiment.

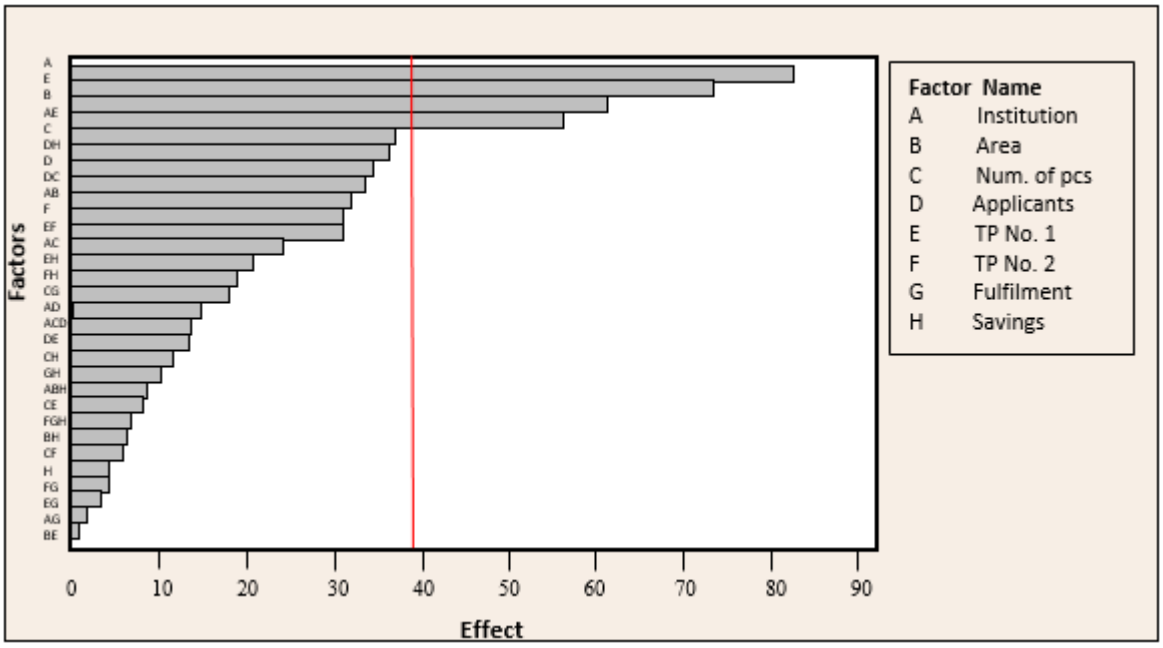

Figure 1. The results of Pareto diagram of effects

The first statistically significant factor is the type of institution, i.e. whether it is a procuring entity financed directly from the state budget or from the budgets of cities and municipalities. The second factor is technical parameter no. 1, i.e. hard disk size of either 1,000 GB or 500 GB. The third statistically significant factor is the same or different area of the contracting authority and the applicant, within the individual regions. The last statistically significant factor is the combination of two factors at once, i.e. type of institution and technical parameter no. 1.

For confirmation, or refuting the results of the Pareto analysis, we decided to use several methods in the next part. The first method used was the probability plot of the normal distribution. In this type of investigation, the points located on the straight line (close to it), which we call the linearized distribution function of the normal distribution, are considered statistically insignificant. On the contrary, all factors located outside the distribution function of the normal distribution are considered statistically significant and therefore have an impact on the response, i.e. for the price. In this case too, a total of four factors affect the response was confirmed, i.e. type of institution, technical parameter no. 1, area and combination of factors, type of institution and parameter no. 1. In this case, we can state, that the results of the Pareto analysis and the probability graph of the normal distribution match.

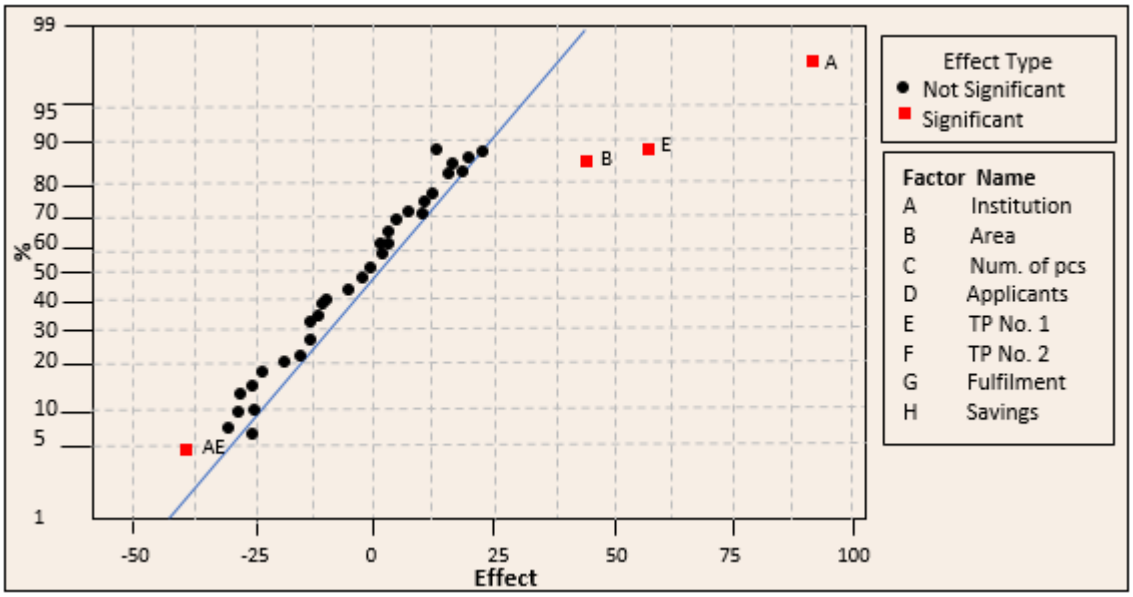

Figure 2. The results of the Normal Probability chart

The main effects of the selected factors were the subject of further investigation, while the main effect is defined as the difference in average responses between the upper and lower levels of individual factors. The results of the examination of main effects are shown in the form of a graph using short lines, with the starting and ending points representing the means for the upper and lower levels of the selected factor. It is true, that if the segment rises from left to right, i.e. upward, so it is a positive effect. With a positive effect, the average response at the upper level is higher, than at the lower level. On the contrary, if the segment descends from left to right, i.e. descending, so the effect is negative. In the case of a negative effect, on the contrary, the average response at the lower level of the factor is higher, than at the upper level. By evaluating the line segments in the graph of the main effects, we come to the conclusion, that the type of institution, area factor, technical parameter no. 1 and technical parameter no. 2 are factors with positive effect. The change compared to previous investigations occurred with the last named variable, but despite the fact, that technical parameter no. 2 has a positive effect on the response, it cannot be considered statistically significant.

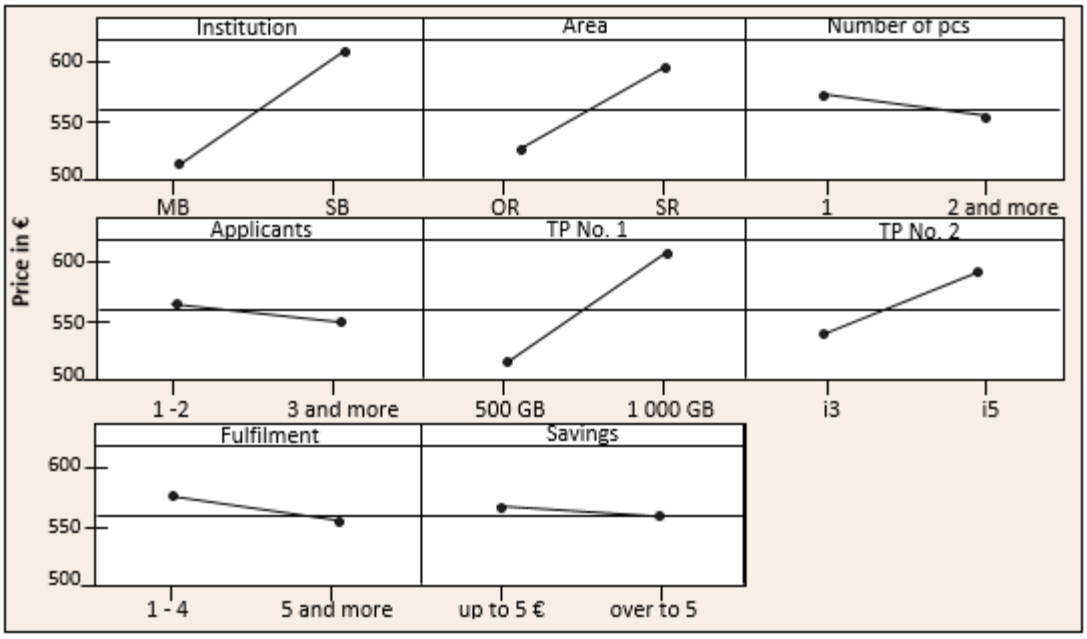

Figure 3. The results of Main effects chart

The last subject of the investigation was the investigation of mutual interactions of individual factors. The results of the Pareto analysis determined the combination of the factors type of institution and technical parameter no. 1 as a statistically significant interaction. In this case too, we tried to confirm or refute these results, for which the interaction graph was used. In general, an interaction plot describes whether the effect of one factor depends on the level of another factor. We can state, that this investigation confirmed several strong and moderate interactions within the selected factors, but only one interaction was statistically significant, i.e. combination of factors, type of institution and technical parameter no. 1. In many cases, research has proven, that some selected factors have no influence on the selected response. Even in this partial investigation, the results of the Pareto analysis regarding mutual interactions of individual factors were confirmed.

4. Discussion

International institutions, including the OECD, have been criticizing the way how public resources are managed through the public procurement system in Slovakia for several years. Among the critical factors of this process are mainly non-coordination between institutions, incorrectly set procedures, low enforceability and, last but not least, low efficiency. For the reasons mentioned above, it would be appropriate to pay more attention to the public procurement process, not only in the form of frequent changes in its legislation. Public procurement itself gives companies a great potential to participate in the competition. If the basic rules set by law were followed within the framework of a transparent competition, it would be possible to reduce not only the state's expenses, but also to satisfy the needs of the public to a greater extent and involve a larger number of applicants from the ranks of business entities. The analysis of public procurements already carried out proves in many ways, that only a small and recurring circle of business entities wins a large part of public

contracts. In the context of public procurement, it is also necessary to monitor this area, i.e. applicants and point out, what affects their success, or failure in this process.

The aim of the presented paper was to identify factors, that have a relevant influence on the price in public procurement in Slovakia from the applicant's point of view. It is the price, that is key in the public procurement process, because it decides, which entity will be successful and which, on the contrary, will not. As a research sample, we mapped public procurement in Slovakia through the electronic marketplace for the period 2019 to 2021 for a selected type of goods, i.e. computing technology, specifically laptops. The results of the planned experiment prove, that a total of three factors and one mutual combination of these factors influence public procurement, which we consider to be statistically significant. Specifically, it was the type of institution, area, technical parameter and mutual combination of the factors of type of institution and technical parameter. In this context, it seems, that every combination of significant factors should also be equally named statistically significant, be it a combination of institution type and area, or area and a technical parameter. However, the results of the Pareto analysis and also the graph of the main effects confirmed, that only one of them can be considered as a statistically significant combination - the type of institution and the technical parameter. In this context, it is important, that the contracts are announced by institutions, that are financed from the state budget, are located in the same region as the applicant, and require laptops with a hard disk parameter of 1,000 GB. On the contrary, the factors, that do not have a decisive influence on the price and which should not be given so much attention include the number of procured pieces, the number of applicants involved, or the number of days of fulfillment.

By comparing the achieved results with similar foreign studies, we can conclude, that the price is the basic measure of the efficiency of the public procurement process. Gregor and Nemec (2015) pointed out in their research, that savings in public procurement are influenced by a total of three factors, i.e. the number of applicants involved, drawing financial resources from European Union structural funds and the lowest price. Studies by Soudek and Skuhrovec (2013), Šipoš and Klatik (2013), Onur et al. (2012), Gómez-Lob and Szymanský (2001), Pavel (2010), Bajari (2002), Nemec et al. (2005) also evaluated the efficiency of public procurement based on the price and the factors, that determine it. The core conclusion of Saudek and Skuhrovec (2013) was, that the key factor determining price was the selection method. On average open tenders delivered a 7% price decrease compared to other methods. Sičáková-Beblavá et al. (2013) analysed 725 procurement actions in 32 Slovak organisations during 2008–2010. They confirm the positive effects of e-auctions and of competition. Finally, some studies have examined how contracting and outsourcing impact on competition. Most of them confirm, that final prices decreased as the number of bids grew and if open tenders were used.

Due to lack of capacity, time, or absence of data, the study has several limitations. It may be mentioned, that we focused only on a selected pre-selected type of product with specific features. Furthermore, the study only concerns public procurement in Slovakia and only for the selected period. Another limitation was the number of measurements and the resulting only partial factor plan. However, all these limitations are removable and could be taken into

account in further research. Enterprises, or researchers, who are not limited by such restrictions can improve and refine the proposed procedure, for example, by replicating the experiment, by repeating it in time intervals, or by applying a full factorial plan.

5. Conclusions

In conclusion, it can be assessed, that the current era provides companies with wide opportunities to apply for public resources, private contracts, or structural funds. The effort to obtain them requires considerable time, financial resources and human capacities on the part of the company in connection with the preparation of project documentation or complex preparation of price offers. Our intention in the submitted paper was to identify relevant factors in the public procurement process, which made it easier for applicants, i.e. companies to choose a contract or project, with the aim of possibly ensuring their success in this process.

Conflict of interest: none.

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Statistical and Forecasting Analysis of the Development of Technical Infrastructure in the Vicinity of Airports in Poland

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Abstract: Research in the field of infrastructural development has attracted quite a lot of interest. A significant part of them concerns the regions of the European Union. However, in the European literature definitely lacks positions in which technical infrastructure is analyzed in catchment areas of airports in Poland. The lack of literature items concerning the infrastructural development of districts located in the overlapping areas of influence of at least two ports is particularly noticeable. The author decided to fill this gap by conducting research, a fragment of which is presented in the text. However, bearing in mind the fact that the development of airports and their accompanying infrastructure causes gradual transformations in the degree of spatial development. Undertaking research on the proposed topic seems particularly important. The main objective was to carry out a prognostic and statistical comparative analysis of the degree of infrastructural development of districts located in the areas of airports in Poland for years 2002-2021. Due to the limited framework of the study, the presented results are only selected. They will apply only to districts located in the catchment areas of the three ports. The medium-term rate of change method was chosen as a forecasting tool.

Keywords: labor market; areas of impact air transport; quantitative methods; air transport; airport; technical infrastructure

JEL Classification: R11; O11

1. Introduction

Many authors undertake research in the field of infrastructural development (Kołodziejczyk, 2017), (Pomianek, 2020), (Surówka, 2009), (Chwastek et al., 2021). Several specific goals were set in the research undertaken by the author. One of them is an attempt to determine whether the processes of economic development in some regions have been and still are conducive to increasing the competitiveness of weaker areas or deepening disproportions. One of the factors affecting the competitiveness of regions is the technical infrastructure, which has become a source of interest in the publication. As some authors rightly point out, the level of infrastructural development can determine the attractiveness of a spatial unit, and therefore constitute an important element of regional or local competitiveness, as well as determine opportunities or threats for further development (Polna, 2017). In the opinion of other authors, it is the technical infrastructure that plays an important role in stimulating social and economic development at the voivodeship, district

and commune level (Chwastek et al., 2021). Broadly understood infrastructure is one of the factors traditionally indicated in theories of development or competitiveness (Pomianek, 2020). There are many definitions of this term in the literature (Surówka, 2007b). Most often, it is understood as the basic devices and institutions providing services necessary for the proper functioning of the economy and the life of society (Lijewski, 1994). One of the definitions defines it as a set of selected devices, building networks and systems directly related to the production of material goods, but necessary for the production process itself. Sometimes it is also identified as a factor expanding or even developing the demand for goods and services. In addition to the diversity of infrastructure concepts, there is also a lack of a uniform classification of this concept. Most often, infrastructure is divided into technical and social. The first one consists of transport, water and sanitary, energy and communication networks, which include, among others, roads, water supply, sewage and gas networks. On the other hand, institutions in the field of education and upbringing, dissemination of culture, health care, social care or housing construction, serving to raise the general standard of living of residents, are referred to as social infrastructure (Kroszel, 1990). Technical infrastructure is quite often defined as a complex of public utility devices necessary primarily to ensure the proper functioning of the national economy and the proper integration of individual systems of socio-economic space. By some authors it is also called economic, technical and economic, production or economic. There are also positions that technical and economic infrastructure is a concept broader than technical. The literature quite often emphasizes the fact that in the case of technical infrastructure there is agreement as to the area of this concept, while in the case of social infrastructure there is no unanimity. An overview of the definition of technical infrastructure can be found in the works of some authors (Surówka, 2007a). It must be stated with all firmness that infrastructure is more and more often associated as a source of competitive advantage. Without an increase in the level of infrastructural development, an appropriate level of development cannot be achieved. Therefore, according to some authors (Sztando, 2004) the development of infrastructure should extend the development of entrepreneurship. It should be based on forecasts and strategic economic plans, because otherwise the infrastructure, instead of being a factor of economic development, may become a brake or even a barrier. The main purpose of the work is to identify the degree of diversification of infrastructural development of districts located in the zones of influence of selected airports in Poland. Weak interest of researchers in the discussed issues was the main premise for undertaking the research.

2. Forecasting as a Research Tool – Research Methodology

Forecasting is the prediction of future phenomena and processes based on scientific foundations. According to another definition, it is a rational, scientific prediction of future events, that is, inferring about unknown events on the basis of known events. In the opinion of another author, it is a scientifically based prediction of the course and state of probable future events (things, facts, phenomenon). Forecasting (prediction) is a scientific way of predicting how future processes and events will develop. Most often they are used to minimize the uncertainty of future events that will arise in the future. Such action provides

information on the subject of interest to us, prompts us to make decisions related to the implementation of the prepared forecast and prepares the occurrence of other actions. The diversity of definitions is justified by the variety of prognostic situations, goals and research methods. The forecasting process must be carefully planned and carefully carried out. Apart from the analyst, the recipient of the forecast should participate in it, who does not need to know the forecasting methods, it is enough that the requirements as to the shape and result are clearly formulated. Forecasting supports decision-making processes and prepares other activities. Many methods are used to make forecasts. In the practical part, the medium-term rate of change method was used (Surówka, 2009). The effectiveness of this deliberation is based on the fact that the dynamics of changes in the examined features is taken into account to forecast the future development of a given phenomenon. As is commonly known, the medium-term rate of changes is used to determine the average rate of changes occurring in a specific time period. With its help, you can make a forecast that will take into account changes over time and in the case of fluctuations in the value of the tested feature, it will indicate the most realistic predicted value. To calculate it, use a specific formula:

$$\overline{T_n} = (\overline{i_g} - 1) \cdot 100\% \tag{1}$$

where:

$$\overline{i_g} = \sqrt[n-1]{i_{n/n-1} \cdot i_{n-1/n-2} \cdot \ldots \cdot i_{2/1}} \tag{2}$$

Thus, it is a geometric mean calculated using individual string indices. Assuming that the value of the medium-term rate of changes will show a similar tendency, the average rate of changes in the value of the phenomenon from year to year, expressed as a percentage, was determined. Then the forecast values were determined according to the formula:

$$K_n = K_0 (1+r)^n \tag{3}$$

K_n – forecast of the value of the feature in the period *n*,
K_0 – value of the variable from the last research period.
r – medium-term pace of change.
n – number of periods.

In scientific research, many methods are used for forecasting, which are based on the current development trend of the phenomenon. The method proposed above can be considered more effective, as it takes into account the dynamics of changes in the studied phenomenon.

3. Forecasting and Statistical Analysis of the Diversification of Infrastructural Development of Districts Located in the Zones of Influence of Katowice Pyrzowice, Kraków Balice and Rzeszów Jasionka Airports

The areas of influence of airports in Poland are defined and named in various ways. According to one definition, it is an area extending within a radius of 100 kilometers from the port. The author took this criterion into account in her research. The names of districts located

in the areas of influence of the three surveyed airports in Poland (Katowice-Pyrzowice Airports, Kraków Balice and Rzeszów Jasionka) were identified on the basis of the methodology described in the literature (Surówka, 2022), and on the basis of already available published information on this subject (Kujawiak, 2016). The results are summarized in Table 1. The name of the city in which the airport is located is given in parentheses.

Table 1. Cities and cities with districts rights belonging to the protection of 100 km of airports in Poland

Katowice – Pyrzowice Airport
Areas: bieruńsko-lędziński (Kraków), chrzanowski, myślenicki (Kraków), oświęcimski (Kraków), bocheński (Rzeszów, Kraków), kluczborski (Wrocław), Jastrzębie-Zdrój (Kraków), wodzisławski, wielicki, krapkowicki, Sosnowiec (Kraków), gliwicki, pajęczański, będziński, Gliwice, Jaworzno (Kraków), Częstochowa, cieszyński, rybnicki (Kraków), nyski (Wrocław), suski (Kraków), Bytom (Kraków), Rybnik (Kraków), wadowicki (Kraków), mikołowski (Kraków), wieluński, opolski (Wrocław), Siemianowice śląskie, Świętochłowice (Kraków), Mysłowice (Kraków), Ruda Śląska, kłobucki, Piekary Śląskie (Kraków), Żory (Kraków), Zabrze, pszczyński (Kraków), kędzierzyńsko - kozielski, Opole (Wrocław), strzelecki, głubczycki, Katowice, radomszczański, zawierciański, krakowski, myszkowski, namysłowski (Wrocław), włoszczowski, miechowski, raciborski, pińczowski (Rzeszów), żywiecki (Kraków), tarnogórski (Kraków), lubliniecki (Kraków), piotrkowski, bełchatowski, Dąbrowa Górnicza (Kraków), łaski, proszowicki (Rzeszów, Kraków), olkuski (Kraków), Bielsko-Biała (Kraków), Tychy (Kraków), prudnicki (Wrocław), oleski, częstochowski, jędrzejowski (Kraków), konecki, brzeski (Wrocław, Rzeszów, Kraków), Chorzów (Kraków), kielecki (Rzeszów), kazimierski (Rzeszów, Kraków), wieruszowski (Wrocław), bielski, (Kraków)
Kraków Balice Airport
Areas: bocheński (Rzeszów, Katowice), brzeski (Rzeszów, Katowice, Wrocław), chrzanowski, dąbrowski, krakowski, limanowski, miechowski, myślenicki (Katowice), nowosądecki (Katowice, Rzeszów), nowotarski, olkuski (Katowice), oświęcimski (Katowice), proszowicki (Rzeszów, Katowice), suski (Katowice), tarnowski (Rzeszów), tatrzański, wadowicki (Katowice), wielicki, Kraków, Nowy Sącz, Tarnów (Rzeszów), będziński, bielski, cieszyński, częstochowski, gliwicki, lubliniecki (Katowice), mikołowski (Katowice), myszkowski, pszczyński (Katowice), rybnicki (Katowice), tarnogórski (Katowice), bieruńsko-lędziński (Katowice), wodzisławski, zawierciański, żywiecki (Katowice), Bielsko-Biała (Katowice), Bytom (Katowice), Chorzów (Katowice), Częstochowa, Dąbrowa Górnicza (Katowice), Gliwice, Jastrzębie-Zdrój (Katowice), Jaworzno (Katowice), Katowice, Mysłowice (Katowice), Piekary Śląskie (Katowice), Ruda Śląska, Rybnik (Katowice), Siemianowice Śląskie, Sosnowiec (Katowice), Świętochłowice (Katowice), Tychy (Katowice), Zabrze, Żory (Katowice), buski (Rzeszów), jędrzejowski (Katowice), kazimierski (Katowice, Rzeszów), pińczowski (Rzeszów, Katowice), włoszczowski
Rzeszów – Jasionka Airport
Areas: biłgorajski, janowski, krasnostawski, kraśnicki, lubelski, tomaszowski (Warszawa), zamojski, bocheński (Katowice, Kraków), brzeski (Katowice, Kraków, Wrocław), dąbrowski, gorlicki, nowosądecki (Katowice, Kraków), proszowicki (Kraków) tarnowski (Kraków), Tarnów (Kraków), lipski, bieszczadzki, brzozowski, dębicki, jarosławski, jasielski, kolbuszowski, krośnieński, leżajski, lubaczowski, łańcucki, mielecki, niżański, przemyski, przeworski, ropczycko-sędziszowski, rzeszowski, sanocki, stalowowolski, strzyżowski, tarnobrzeski, leski, Krosno, Przemyśl, Rzeszów, miasto Tarnobrzeg, buski (Kraków), kazimierski (Kraków, Katowice), kielecki (Katowice), opatowski, ostrowiecki, pińczowski (Kraków, Katowice), sandomierski, staszowski

At the beginning, for the units located in the area of influence of the three surveyed ports, statistical material was collected for the characteristics that are most often used to define the technical infrastructure. Finally, the examined category was determined by means of nine measures. In the publication, the results refer only to the three that are most often used to measure infrastructure development. The choice of these measures was dictated by the

possibility of obtaining relevant statistical information and based on previous research experience (Kołodziejczyk, 2017), (Klepacka-Dunajko et al., 2017), (Chwastek et al., 2021), (Polna, 2017). Finally, the following indicators were proposed:

1. X_1 – length of the sewage network in km per 100 km^2 of area,
2. X_2 – length of the water supply network in km per 100 km^2 of area,
3. X_3 – length of the gas network in km per 100 km^2 of area,
4. X_4 – percentage of all dwellings connected to the water supply system,
5. X_5 – percentage of all dwellings connected to the sewage system,
6. X_6 – length of public commune district hard surface roads in km per 100 km2 of surface,
7. X_7 – length of public commune district roads with unsurfaced surface in km per 100 km2 of area,
8. X_8 – length of municipal and district public roads with improved hard surface (in km),
9. X_9 – population using sewage treatment plants as a percentage of the total population (%).

Statistical data for the features selected for the study in the cross-section of districts for the research period 2000-2018 were obtained from the Local Data Bank. The collected material was statistically processed. Basic statistical measures were determined, and the results are summarized in Table 2.

Table 2. Selected descriptive measures of infrastructural development of districts located in the zones of influence of airports in Krakow, Rzeszów and Katowice

	X_{mean}	Min	Max	Me	Q1	Q3	V_s	X_{mean}	Min	Max	Me	Q1	Q3	V_s
	AREA OF IMPACT OF RZESZOW-JASIONKA AIRPORT							AREA OF IMPACT OF KATOWICE – PYRZOWICE AIRPOT						
X_1	116.39	4.8	651.8	84.7	42	123.2	109.71	171.68	20.6		706.3	43.75	129.10	94.26
X_2	138.11	8.2	539.3	112.5	64	153.2	81.97	227.38	54.6	676.2	153.25	103.75	334.80	72.1
X_3	136.89	0.20	712.8	103	47.7	155,9	11.53	187.80	0.4	685.5	136.5	18.25	302.75	98.89
X_4	77.38	17.8	100	84	71.7	90.4	25.28	90.24	36.5	100	93.85	87.65	97.35	12.55
X_5	51.94	15.1	96.8	54.4	33.2	67.5	21.81	55.67	15.7	100	50.00	39.85	73.60	39.43
X_6	124.75	21.7	377.7	103	83.5	146.9	57.69	176.16	59.0	502.6	154.25	93.95	245.35	56.19
X_7	26.22	0	67.1	23.3	13.2	31.5	62.82	23.90	2.20	150.7	18.90	10.9	28.90	94.92
X_8	340.12	43.6	904.4	314.1	234.8	406.6	53.06	253.21	23.4	904.4	246.8	103.55	328.80	66.13
X_9	63.6	18.5	100	64.3	48.2	79.2	32.6	70.01	34.6	99.9	67.95	56.55	86.05	26.54
AREA OF IMPACT OF KRAKÓW BALICE AIRPORT														
X_1	219.96	20.6	706.3	145.85	78.95	373.3	79.02							
X_2	269.43	27.5	676.2	220.65	125.1	416.7	63.51							
X_3	257.04	0.4	685.5	231.2	86.75	427.4	74.4							
X_4	89.91	40.6	100	97.35	86.55	99.40	15.97							
X_5	69.01	29.7	100	67.8	52.8	88.65	29.72							
X_6	212.67	75.9	502.6	189.35	122.8	268	45.30							
X_7	26.07	0	150.7	19.70	10.9	31.5	94.63							
X_8	231.37	23.4	672.9	221.7	93.25	314.3	71.45							
X_9	72.07	34.6	100	69.80	55.25	90.65	27.31							

Due to the assumed purpose of the study, the conducted analysis focused only on units located in the catchment area of three selected ports. And the results of the analysis were narrowed down to three variables. By analyzing the table above, we can see that the highest average value of the X1 (length of the sewage network in km per 100 km2 of area), X2 (length of the water supply network in km per 100 km2 of area) oraz X3 (length of the gas network in

Table 3. Forecast of the length of the distribution network in districts located in the zone of impact of Rzeszów-Jasionka Airport (2021-2022)

	2021	2022	2023		2021	2022	2023		2020	2022	2023	
Districts name	Variable X_1			R	Variable X_2			R	Variable X_3			R
Biłgorajski	40.3	44.31	46.46	38	61.7	62.63	63.09	39	27.5	28.16	28.50	42
Janowski	8.4	8.99	9.29	48	53.1	54.06	54.54	45	19.2	21.08	22.09	44
Krasnostawski	25.5	27.76	28.96	43	87.9	88.44	88.71	35	39.4	40.45	40.99	38
Kraśnicki	26.6	29.91	31.71	42	94.4	96.48	97.53	34	65.8	67.41	68.24	33
Lubelski	29.8	34.92	37.80	40	137.2	140.42	142.06	18	110.2	115.82	118.74	23
Tomaszowski	18.7	19.33	19.66	45	64.0	64.71	65.07	37	24.9	27.21	28.45	43
Zamojski	14.7	16.31	17.19	46	59.7	60.95	61.58	41	50.5	52.78	53.96	36
Bocheński	106.3	116.02	121.21	18	156.6	163.69	167.36	10	198.7	206.50	210.51	7
Brzeski	90.4	100.67	106.24	23	153.3	160.84	164.75	12	193.8	199.34	202.17	10
Dąbrowski	73.0	76.11	77.72	30	193.3	194.68	195.38	7	155.9	156.96	157.50	15
Gorlicki	112.3	126.25	133.87	15	50.4	58.69	63.33	38	129.0	133.70	136.12	16
Nowosądecki	89.9	95.75	98.82	26	117.2	126.23	131.01	20	119.7	128.75	133.52	20
Proszowicki	62.5	64.68	65.79	33	187.6	187.30	187.15	8	69.1	73.55	75.88	29
Tarnowski	125.5	132.02	135.41	13	136.0	142.63	146.07	17	197.8	203.66	206.66	8
Tarnów	517.1	526.10	530.67	2	459.7	469.65	474.70	3	564.7	584.09	594.04	3
Lipski	9.7	10.64	11.14	47	94.7	98.1f0	99.85	33	0.2	0.2	0.2	49
Bieszczadzki	4.8	5.09	5.24	49	8.2	8.36	8.45	49	0.4	0.31	0.28	48
Brzozowski	135.9	147.19	153.18	10	31.0	37.23	40.80	47	134.2	134.38	134.47	17
Dębicki	123.2	133.07	138.30	11	139.9	145.10	147.78	16	188.0	195.57	199.47	11
Jarosławski	122.7	126.73	128.79	17	106.6	108.29	109.15	29	102.5	105.56	107.12	25
Jasielski	112.4	117.46	120.07	19	52.7	55.69	57.25	42	154.5	159.70	162.37	13
Kolbuszowski	104.6	109.45	111.96	20	102.0	103.62	104.45	31	102.2	104.07	105.01	26
Krośnieński	133.0	135.65	137.00	12	58.3	60.65	61.86	40	130.2	133.00	134.43	18
Leżajski	115.7	125.41	130.57	16	112.5	116.29	118.24	25	103.0	104.29	104.94	27
Lubaczowski	51.8	55.79	57.90	35	48.2	49.80	50.62	46	34.5	36.02	36.81	39
Łańcucki	255.9	264.67	269.17	5	184.1	196.28	202.66	6	219.4	229.27	234.36	6
Mielecki	100.9	107.18	110.46	21	159.7	162.84	164.43	13	127.0	131.47	133.76	19
Niżański	97.3	105.47	109.80	22	103.4	104.66	105.30	30	73.0	74.43	75.15	31
Przemyski	65.8	69.19	70.94	32	51.2	54.03	55.50	43	58.4	59.38	59.87	35
Przeworski	154.9	160.18	162.89	8	115.8	118.12	119.30	23.5	116.3	118.23	119.21	22
Ropczycko-sedz.	130.1	151.02	162.72	9	115.8	118.12	119.30	23.5	152.3	158.57	161.81	14
Rzeszowski	173.5	181.68	185.92	7	151.2	161.76	167.31	11	191.5	200.46	205.09	9
Sanocki	74.9	82.76	87.00	28	45.8	51.72	54.96	44	66.5	69.37	70.84	32
Stalowowolski	71.1	76.65	79.58	29	96.6	99.20	100.53	32	83.7	86.98	88.67	28
Strzyżowski	77.8	90.55	97.69	27	80.0	79.65	79.47	36	170.1	172.36	173.50	12
Tarnobrzeski	121.4	130.50	135.30	14	108.8	110.28	111.02	28	114.4	116.48	117.53	24
Leski	31.4	33.78	35.04	41	26.6	27.53	28.00	48	19.5	20.08	20.37	45
Krosno	386.2	399.91	406.94	4	526.6	554.75	569.38	2	662.9	698.49	716.99	2
Przemyśl	400.9	409.62	414.05	3	358.0	366.89	371.41	4	430.3	468.66	489.11	4
Rzeszów	651.8	691.63	712.45	1	539.3	560.33	571.16	1	712.8	764.58	791.86	1
Tarnobrzeg	220.3	233.58	240.51	6	239.3	248.43	253.12	5	230.1	240.75	246.26	5
Buski	64.8	69.11	71.37	31	122.3	123.09	123.49	22	63.2	65.50	66.69	34
Kazimierski	32.9	36.55	38.52	39	153.2	158.09	160.59	14	0.4	0.4	0.4	47
Kielecki	84.7	95.27	101.04	24	129.8	133.62	135.58	19	20.8	25.94	28.97	41
Opatowski	24.5	26.71	27.89	44	127.0	128.07	128.61	21	47.7	49.83	50.92	37
Ostrowiecki	83.0	93.36	99.01	25	148.9	149.73	150.15	15	69.3	73.34	75.45	30
Pińczowski	42.0	45.43	47.25	37	112.2	114.13	115.11	26	10.8	13.79	15.58	46
Sandomierski	45.2	49.15	51.25	36	181.3	184.69	186.41	9	118.8	124.05	126.76	21
Staszowski	56.9	59.31	60.56	34	110.9	111.88	112.87	27	32.3	34.07	34.99	40

km per 100 km2 of area) is characteristic for the catchment area of the Kraków-Balice Airport, and the lowest is for Rzeszow-Jasionka. The examined features are characterized by statistically significant differentiation. The highest value of the coefficient of variation has features X1 (area of influence of Rzeszów-Jasionka and Katowice-Pyrzowice Airports) and X7 (area of influence of Kraków-Balice Airport). The percentage of all dwellings connected to the water supply system was also examined. The highest average level of this feature is characteristic for the Katowice-Pyrzowice catchment area, and the lowest for Rzeszów-Jasionka. In the next stage, the prediction of the studied features was made. The medium-term rate of change method was chosen as the research tool. The prognosis period was 2022-2023. The results for the first three indicators are presented in Tables 3-5. Districts located in the zones of influence of at least two airports are bolded in italics.

Analyzing the information in Table 3 above, we notice that the length of the distribution network in the districts located in the zone of influence of the Rzeszów-Jasionka Airport varies. Rzeszów, the districts in which the airport is located, can be considered a leader in terms of this feature. The highest positions are occupied by district cities. Tomaszowski district is also located within the area of influence of the Warsaw Airport. It occupies distant positions in the ranking due to the studied features. The Bieszczady and Lipski districts are definitely the worst. Districts located in the area of influence of more than one airport occupy distant positions in terms of infrastructural development. Similar forecasts were made for the area of influence of Kraków-Balice Airport. The results are summarized in Table 4. Analyzing the information contained therein, we can see that there are more units located in the zone of more than one airport compared to the area of influence of the Rzeszów-Jasionka Airport.

Analyzing the information contained in Table 4, we can notice a very large differentiation of the positions occupied in the rankings in terms of the examined features. The highest position in the ranking for the forecast of the length of the distribution network in districts

Table 4. Forecast of the length of the distribution network in districts located in the zone of impact of Kraków-Balice Airport (2021-2022) – Part 1

	2021	2022	2023		2021	2022	2023		2021	2022	2023	
Districts name	Variable X_1			R	Variable X_2			R	Variable X_3			R
Bocheński	106.3	116.02	121.21	38	156.6	163.69	167.36	38	198.7	206.50	210.51	33
Brzeski	90.4	100.67	106.24	39	153.3	160.84	164.75	39	193.8	199.34	202.17	35
Chrzanowski	126.9	128.37	129.11	37	209.0	211.53	212.80	31	243.1	262.90	273.40	26
Dąbrowski	73.0	75.61	76.95	46	193.3	194.96	195.80	35	155.9	157.22	157.89	39
Krakowski	182.3	195.81	202.94	25	237.6	245.69	249.83	27	262.3	275.57	282.46	25
Limanowski	84.9	93.29	97.78	43	86.7	90.55	92.54	54	153.0	162.37	167.28	38
Miechowski	20.6	20.80	20.91	60	139.7	140.20	140.46	42	32.0	36.31	38.68	53
Myślenicki	150.2	152.89	154.26	31	131.0	133.42	134.65	43	165.2	171.87	175.31	37
Nowosądecki	89.9	95.75	98.82	42	117.2	126.23	131.01	46	119.7	128.75	133.52	44
Nowotarski	90.1	94.06	96.10	44	27.5	27.84	28.01	60	39.1	42.38	44.13	52
Olkuski	46.7	48.46	49.36	53	123.7	125.45	126.33	47	135.8	140.36	142.69	42
Oświęcimski	187.7	201.68	209.06	24	250.3	253.37	254.93	26	275.4	285.42	290.57	23
Proszowicki	62.5	64.68	65.79	51	187.6	187.30	187.15	37	69.1	73.55	75.88	47
Suski	70.0	79.55	84.80	45	54.6	55.78	56.38	59	17.7	19.00	19.69	56
Tarnowski	125.5	132.02	135.41	35	136.0	142.63	146.07	41	197.8	203.66	206.66	34
Tatrzański	94.6	98.15	99.98	41	62.2	63.45	64.08	58	27.1	33.08	36.55	54

Table 4. Forecast of the length of the distribution network in districts located in the zone of impact of Kraków-Balice Airport (2021-2022) – Part 2

	2021	2022	2023		2021	2022	2023		2021	2022	2023	
Districts name	Variable X_1			R	Variable X_2			R	Variable X_3			R
Wadowicki	135.1	146.20	152.09	32	194.2	199.70	202.50	33	251.2	253.89	255.25	29
Wielicki	125.4	134.78	139.73	34	332.8	347.39	354.93	19	346.9	361.32	368.75	19
Kraków	485.3	504.22	513.95	6	473.7	489.80	198.06	34	587.6	609.35	620.52	5
Nowy sącz	586.0	602.71	611.24	2	500.2	522.64	534.23	7	683.9	794.16	784.08	1
Tarnów	517.1	526.10	530.67	5	459.7	469.65	474.70	11	564.7	584.09	594.04	6
Będziński	133.7	151.22	160.83	29	227.3	234.99	238.94	28	249.4	261.85	268.30	27
Bielski	173.9	182.04	186.25	26	285.6	290.96	293.68	23	342.4	350.25	354.24	20
Cieszyński	149.5	158.65	163.43	28	184.4	188.33	190.32	36	250.6	261.68	267.40	28
Częstochowski	46.2	49.84	51.77	52	99.5	101.88	103.08	51	54.3	60.33	63.58	49
Gliwicki	63.9	66.65	68.08	48	114.7	116.92	118.04	49	74.3	86.99	94.12	46
Lubliniecki	63.5	65.08	65.88	50	98.2	97.03	96.45	53	23.0	25.64	27.07	55
Mikołowski	227.0	228.42	229.13	23	302.7	308.99	312.18	21	219.3	237.48	147.12	41
Myszkowski	40.3	42.86	44.20	55	130.5	132.28	133.18	44	99.2	109.18	114.55	45
Pszczyński	153.9	156.77	158.23	30	201.2	205.80	208.14	32	205.9	214.58	219.06	32
Rybnicki	121.6	127.37	130.36	36	222.1	225.71	227.54	29	114.3	129.39	137.66	43
Tarnogórski	96.6	99.69	101.27	40	126.5	130.28	132.22	45	137.2	149.24	155.65	40
Bieruńsko-lędziński	372.3	375.18	376.62	18	253.8	260.21	263.48	25	251.7	285.54	304.13	22
Wodzisławski	326.8	355.63	370.98	19	284.5	291.46	295.00	22	214.9	226.68	232.81	31
Zawierciański	34.1	36.12	37.17	58	100.2	101.22	101.73	52	53.1	54.43	55.11	50
Żywiecki	163.1	175.91	182.69	27	82.2	87.06	89.59	55	44.0	44.41	44.61	51
Bielsko-biała	706.3	724.24	733.38	1	561.2	570.61	575.37	4	509.9	524.87	532.52	8
Bytom	402.1	409.57	413.36	13	488.5	491.09	492.40	9	454.6	479.41	492.33	14
Chorzów	142.0	85.65	66.52	49	571.3	571.20	571.15	6	615.4	653.89	674.03	3
Częstochowa	373.0	376.81	378.73	16	403.4	409.44	412.50	16	435.3	482.47	507.94	11
Dąbrowa górnicza	180.7	212.19	229.94	22	219.2	221.48	222.63	30	254.2	275.54	286.87	24
Gliwice	341.1	359.65	369.30	20	336.8	347.48	352.94	20	430.9	462.14	478.59	15
Jastrzębie-zdrój	373.6	394.09	404.75	14	448.4	444.50	442.57	13	327.6	342.93	350.86	21
Jaworzno	265.4	287.35	299.00	21	261.4	274.76	281.69	24	165.2	174.86	179.90	36
Katowice	398.9	410.62	416.61	12	434.5	443.31	447.79	12	450.9	474.63	496.96	13
Mysłowice	418.8	418.8	418.8	11	497.7	495.98	495.12	8	423.9	438.52	446.02	17
Piekary śląskie	392.9	396.64	398.52	15	344.2	364.05	374.41	18	395.8	421.77	435.38	18
Ruda śląska	359.2	371.73	378.15	17	390.6	395.45	397.90	17	417.4	456.20	476.93	16
Rybnik	433.2	434.95	435.82	10	413.8	421.73	425.75	15	265.3	254.48	249.24	30
Siemianowice śląskie	515.7	556.40	577.94	3	636.9	660.05	671.94	2	564.7	612.24	637.49	4
Sosnowiec	476.6	518.47	540.77	4	558.8	567.57	572.00	5	488.6	515.31	529.20	9
Świętochłowice	252.4	178.17	149.70	33	676.2	716.37	737.35	1	685.5	719.68	737.40	2
Tychy	454.3	457.41	458.97	8	569.6	580.94	586.69	3	445.8	486.60	508.38	10
Zabrze	470.9	481.38	486.71	7	419.5	429.49	434.58	14	514.1	541.97	556.47	7
Żory	425.4	444.93	455.03	9	444.8	469.76	482.76	10	436.6	478.00	500.15	12
Buski	64.8	69.11	71.37	47	122.3	123.09	123.49	48	63.2	65.50	66.69	48
Jędrzejowski	22.2	22.58	22.77	59	80.0	82.48	83.75	56	8.1	11.99	14.58	58
Kazimierski	32.9	36.55	38.52	57	153.2	158.09	160.59	40	0.4	0.4	0.4	60
Pińczowski	42.0	45.43	47.25	54	112.2	114.13	115.11	50	10.8	13.79	15.58	57
Włoszczowski	36.5	38.02	38.80	56	81.1	82.55	83.29	57	5.0	8.28	10.66	59

Table 5. Forecast of the length of the distribution network in districts located in the zone of impact of Katowice-Pyrzowice Airport (2021-2022) – Part 1

	2021	2022	2023		2021	2022	2023		2021	2022	2023	
Districts name	Variable X_1			R	Variable X_2			R	Variable X_3			R
Bełchatowski	45.5	48.77	50.49	53	135.6	138.25	139.59	40	18.8	20.10	20.79	54
Łaski	27.6	29.21	30.04	69	125.7	127.57	128.52	46	11.0	14.68	16.96	59
Pajęczański	27.2	29.63	30.93	67	107.9	109.40	110.16	52	9.6	10.30	10.67	68
Piotrkowski	27.8	29.88	30.97	66	108.3	108.46	180.53	35	10.6	13.83	15.80	60
Radomszczański	32.1	34.57	35.87	63	101.7	103.06	103.75	55	12.1	13.27	13.89	67
Wieluński	40.1	44.74	47.26	56	114.3	115.54	116.16	49	13.8	15.85	16.99	58
Wieruszowski	50.8	52.77	53.79	51	108.3	110.21	111.18	51	6.1	7.14	7.73	70
Bocheński	106.3	116.02	121.21	35	156.6	163.69	167.36	36	198.7	206.50	210.51	31
Brzeski	90.4	100.67	106.24	36	153.3	160.84	164.75	37	193.8	199.34	202.17	32
Chrzanowski	126.9	128.27	128.97	34	209.0	210.68	211.53	30	243.1	256.73	263.82	26
Krakowski	182.3	207.73	221.74	22	237.6	246.33	250.81	26	262.3	276.17	283.38	22
Miechowski	20.6	21.17	21.47	72	139.7	140.26	140.54	39	32.0	35.60	37.55	47
Myślenicki	150.2	152.89	154.26	28	131.0	133.42	134.65	42	165.2	171.87	175.31	34
Olkuski	46.7	48.46	49.36	55	123.7	125.45	126.33	47	135.8	140.36	142.69	37
Oświęcimski	187.7	201.68	209.06	23	250.3	253.37	254.93	25	275.4	285.42	290.57	20
Proszowicki	62.5	64.68	65.79	47	187.6	187.30	187.15	34	69.1	73.55	75.88	41
Suski	70.0	79.55	84.80	43	54.6	55.78	56.38	72	17.7	19.00	19.69	56
Wadowicki	135.1	146.20	152.09	30	194.2	199.70	202.50	32	251.2	253.89	255.25	27
Wielicki	125.4	134.11	138.69	32	332.8	347.02	354.35	18	346.9	361.41	368.88	16
Głubczycki	31.5	34.04	35.34	64	56.4	56.74	56.91	71	14.2	14.77	15.06	64
Kędzierzyńsko-k	89.7	95.21	98.09	40	105.8	107.42	108.24	54	34.1	36.01	37.00	48
Kluczborski	28.6	31.51	33.07	65	64.4	64.92	65.19	70	17.0	18.76	19.71	55
Krapkowicki	89.4	99.19	104.49	37	91.6	92.40	92.80	60	43.6	46.83	48.54	45
Namysłowski	29.3	35.34	38.82	60	64.6	66.06	66.81	68	12.8	14.50	15.43	62.5
Nyski	48.4	52.84	55.21	50	81.5	85.73	87.93	63	29.8	32.21	33.49	50
Oleski	20.9	21.71	22.13	71	88.1	89.47	90.16	61	12.8	14.50	15.43	62.5
Opolski	80.1	87.73	91.81	41	87.4	87.56	87.63	64	26.1	32.83	36.82	49
Prudnicki	27.8	29.37	30.19	68	64.1	64.90	65.31	69	14.0	14.41	14.62	65
Strzelecki	68.9	75.78	79.47	44	70.5	71.11	71.42	67	23.2	27.33	29.66	51
Opole	376.7	397.79	408.78	11	348.7	361.39	367.90	17	277.9	277.04	276.61	23
Będziński	133.7	146.50	153.35	29	227.3	232.83	235.64	27	249.4	260.31	265.94	24
Bielski	173.9	182.04	186.25	24	285.6	290.96	293.68	22	342.4	350.25	354.24	17
Cieszyński	149.5	162.37	169.21	26	184.4	189.60	192.26	33	250.6	260.56	265.68	25
Częstochowski	46.2	50.78	53.23	52	99.5	101.77	102.92	56	54.3	59.10	61.65	43
Gliwicki	63.9	78.93	87.72	42	114.7	117.50	118.93	48	74.3	83.99	89.30	40
Kłobucki	50.4	55.87	58.82	49	107.2	108.37	108.96	53	5.4	6.47	7.08	71
Lubliniecki	63.5	65.08	65.88	46	98.2	97.03	96.45	59	23.0	25.64	27.07	53
Mikołowski	227.0	228.42	229.13	21	302.7	308.99	312.18	20	219.3	237.48	147.12	36
Myszkowski	40.3	42.10	43.03	58	130.5	132.44	133.43	43	99.2	106.39	110.18	39
Pszczyński	153.9	156.77	158.23	27	201.2	205.80	208.14	31	205.9	214.58	219.06	30
Raciborski	56.9	61.57	64.05	48	127.1	128.26	128.85	45	61.4	62.52	63.09	42
Rybnicki	121.6	127.37	130.36	33	222.1	225.71	227.54	28	114.3	129.39	137.66	38
Tarnogórski	96.6	99.69	101.27	38	126.5	130.28	132.22	44	137.2	149.24	155.65	35
Bieruńsko-lędziński	372.3	375.18	376.62	17	253.8	260.21	263.48	24	251.7	285.54	304.13	19
Wodzisławski	326.8	369.70	393.22	14	284.5	290.72	293.89	21	214.9	224.57	229.56	29
Zawierciański	34.1	35.57	36.33	62	100.2	101.28	101.82	57	53.1	54.33	54.96	44
Żywiecki	163.1	175.91	182.69	25	82.2	87.06	89.59	62	44.0	44.41	44.61	46
Bielsko-biała	706.3	724.24	733.38	1	561.2	570.61	575.37	4	509.9	524.87	532.52	5
Bytom	402.1	409.57	413.36	10	488.5	491.09	492.40	8	454.6	479.41	492.33	10
Chorzów	142.0	85.65	66.52	45	571.3	571.20	571.15	6	615.4	653.89	674.03	2
Częstochowa	373.0	379.60	382.94	15	403.4	411.89	416.21	14	435.3	477.74	500.49	8
Dąbrowa górnicza	180.7	212.19	229.94	20	219.2	221.48	222.63	29	254.2	275.54	286.87	21
Gliwice	341.1	361.57	372.27	18	336.8	345.42	349.81	19	430.9	453.63	465.45	13
Jastrzębie-zdrój	373.6	394.09	404.75	12	448.4	444.50	442.57	11	327.6	342.93	350.86	18
Jaworzno	265.4	287.35	299.00	19	261.4	274.76	281.69	23	165.2	174.86	179.90	33
Katowice	398.9	426.53	441.06	7	434.5	440.00	442.77	10	450.9	471.01	481.41	11
Mysłowice	418.8	418.8	418.8	9	497.7	495.98	495.12	7	423.9	438.52	446.02	14

Table 5. Forecast of the length of the distribution network in districts located in the zone of impact of Katowice-Pyrzowice Airport (2021-2022) – Part 2

	2021	2022	2023		2021	2022	2023		2021	2022	2023	
Districts name	Variable X_1			R	Variable X_2			R	Variable X_3			R
Piekary śląskie	392.9	396.64	398.52	13	344.2	364.05	374.41	16	395.8	421.77	435.38	15
Ruda śląska	359.2	371.39	377.64	16	390.6	395.21	397.54	15	417.4	448.99	465.67	12
Rybnik	433.2	434.95	435.82	8	413.8	421.73	425.75	13	265.3	254.48	249.24	28
Siemianowice śląskie	515.7	543.32	557.67	2	636.9	701.86	736.78	2	564.7	609.17	632.70	3
Sosnowiec	476.6	518.47	540.77	3	558.8	567.57	572.00	5	488.6	515.31	529.20	6
Świętochłowice	252.4	178.17	149.70	31	676.2	716.37	737.35	1	685.5	719.68	737.40	1
Tychy	454.3	457.41	458.97	5	569.6	580.94	586.69	3	445.8	486.60	508.38	7
Zabrze	470.9	481.38	486.71	4	419.5	429.49	434.58	12	514.1	541.97	556.47	4
Żory	425.4	444.93	455.03	6	444.8	469.76	482.76	9	436.6	478.00	500.15	9
Jędrzejowski	22.2	22.58	22.77	70	80.0	82.48	83.75	65	8.1	11.99	14.58	66
Kazimierski	32.9	36.55	38.52	61	153.2	158.09	160.59	38	0.4	0.4	0.4	72
Kielecki	84.7	95.27	101.04	39	129.8	133.62	135.58	41	20.8	25.94	28.97	52
Konecki	39.9	46.16	49.66	54	94.9	96.02	96.59	58	16.0	17.42	18.18	57
Pińczowski	42.0	45.43	47.25	57	112.2	114.13	115.11	50	10.8	13.79	15.58	61
Włoszczowski	36.5	38.93	40.21	59	81.1	82.84	83.73	66	5.0	8.28	10.66	69

located in the zone of impact of Kraków-Balice Airport is held by Bielsko-Biała, and the lowest by the Miechów district. Similar forecasts of the distribution network were prepared for districts located in the zone of influence of the Katowice-Pyrzowice Airport. The results are presented in Table 5.

4. Discussion and Conclusion

The subject of the work were issues related to the development of technical infrastructure in catchment areas of airports in Poland. The aim was to identify differences in the development of selected elements of the technical infrastructure of the counties located in the zones of influence of the surveyed units. In the course of the study, a statistical assessment of the level of infrastructural development of units located in the impact zones of three selected airports was made. In the next stage of the study, the values of the measures characterizing the length of the distribution network for the years 2022-2023 were predicted. Thanks to this, it was possible to assess the rate of change of the examined features. The need for forecasting is most often due to the desire to know the future. Statistical studies conducted so far in the field of the analyzed issues have contributed to obtaining, among others, the following results: for the majority of the surveyed districts, the length of the distribution network is increasing, the decrease applies only to a few. The results of the forecasts obtained allow us to claim that nothing will change in this respect. Similar trends in their research were also noticed by other authors (see Błachut et al. (2018) or Kałuża-Jurczyńska et al. (2021)). We also observe a similar rate of development of the distribution network for all the surveyed units. In the course of the analysis, it was also observed that the examined units are characterized by statistically significant differences. Similar results can also be found in the works of other authors (see Bożek and Szewczyk (2014) or Kołodziejczyk (2017)). The values of variables characterizing the distribution network are higher than the average in the catchment area of the Rzeszów-Jasionka Airport in cities with district rights and provincial capital (Tarnów, Krosno, Przemyśl, Rzeszów, Tarnobrzeg). As noted by other researchers, these are districts

with the best conditions for social and economic development (Gawroński et al., 2014). These are units with very high positions in the rankings. The values of the feature length of the sewage network in km per 100 km2 are higher than the average in the area of influence of this port, apart from district cities, also for the following districts: tarnowski, brzozowski, dębicki, jarosławski krośnieński, łańcucki, przeworski, ropczycko – sędziszowski, rzeszowski, tarnobrzeski. In the case of the X2 feature, these are, as for the X1 feature, cities with district rights and districts: bocheński, brzeski, dąbrowski, proszowicki, dębicki, łańcucki, mielecki, rzeszowski, kazimierski, ostrowiecki, sandomierski). It is worth noting that the Bochnia and brzeski districts are located in the zones of influence of all three airports surveyed. In the Bochnia district, large investments in the sewage system have been carried out recently and over the eight compared years, the percentage of people using the sewage system increased from 44.7 percent in 2010 to 57.4 percent. Along with a slight increase in the number of people using the sewage system, the percentage of people using sewage treatment plants increased from 50.2 to 60.3 percent (Strategia rozwoju powiatu bocheńskiego na lata 2021-2023). These results are similar to the results obtained as a result of own research. The variable X3 was also examined (length of the gas network in km per 100 km2 of area). Higher than average values for this feature were also recorded by cities with district rights, provincial capital and district units: bocheński, brzeski, dąbrowski, tarnowski, dębicki, jasielski, łańcucki, ropczycko – sędziszowski, rzeszowski, strzyżowski. For feature X4, these were districts: biłgorajski, janowski, krasnostawski, karśnicki, lubelski, dąbrowski, proszowicki, lipski, jarosławski, kolbuszowski, leżajski, lubaczowski, łańcucki, mielecki, niżański, przeworski, ropczycko-sędziszowski, rzeszowski, stalowowolski, tarnobrzeski, buski, kazimierski, kielecki, opatowski, ostrowiecki, pińczowski, sandomierski, staszowski. Percentage of all dwellings connected to the sewage system districts have a higher than average percentage of dwellings connected to the sewage system: biłgorajski, bocheński, gorlicki, brzozowski, dębicki, jarosławski, jasielski, kolbuszowski, krośnieński, leżajski, lubaczowski, łańcucki, mielecki, niżański, przemyski, przeworski, ropczycko-sędziszowski, rzeszowski, sanocki, tarnobrzeski, kielecki, ostrowiecki. When analyzing the catchment area of the Katowice-Pyrzowice Airport, in the case of the X1 feature, higher than average values were recorded mainly by districts located in the area of influence of more than one airport (oświęcimski, bielski, mikołowski, bieruńko-lędzieński, Bielsko-Biała, Bytom, Dąbrowa Górnicza, Jastrzębie Zdrój, Jaworzno, Mysłowice, Piekary Śląskie, Rybnik, Sosnowiec, Świętochłowice, Tychy Zabrze, Żory). This group includes the oświęcimski district, which occupies the highest position in the ranking in the field of infrastructural development of districts in the Śląskie Voivodeship (Polna, 2017). Apart from them, there were districts and cities with district rights: krakowski, Opole, wodzisławski, Częstochowa, Gliwice, Katowice, Ruda Śląska, Siemianowice Śląskie. In the case of the X2 feature, these were also cities with district rights (Opole, Bielsko-Biała, Bytom, Chorzów, Częstochowa, Gliwice, Jastrzębie Zdrój, Jaworzno, Katowice, Mysłowice, Piekary Śląskie, Ruda Śląska, Rybnik, Siemianowice Śląskie, Sosnowiec, Świętochłowice, Tychy, Zabrze, Żory). In addition to the districts: krakowski, oświęcimski, wielicki, bielski, mikołowski, bieruńsko-lędziński, wodzisławski. Świętochłowice is district also located in the zone of influence of the Katowice-Pyrzowice

Airport. It occupies the high position in terms of forecast of the length of the distribution network in the zone of influence of the Kraków-Balice and Katowice-Pyrzowice Airports. It also occupies a high or very high position in the rankings of infrastructure development prepared by other authors (Polna, 2017). In the area of influence of the Katowice-Pyrzowice Airport, higher values for the X3 feature are found in cities with district rights, provincial capital and districts: bocheński, brzeski, chrzanowski, krakowski, oświęcimski, wadowicki, wielicki, będziński, bielski, cieszyński, mikołowski, pszczyński, bieruński-lędziński, wodzisławski. Districts located in the zone of influence of Kraków-Balice Airport were also assessed against the average. Values higher than the average for the X1 variable were recorded similarly to the previous areas of influence for cities with district rights and provincial capital (Kraków, Nowy Sącz, Tarnów, Bielsko-Biała, Bytom, Częstochowa, Gliwice, Jastrzębie – Zdrój, Jaworzno, Katowice, Mysłowice, Piekary Śląskie, Ruda Śląska, Rybnik, Siemianowice Śląskie, Sosnowiec, Świętochłowice, Tychy Zabrze, Żory) and for district units: mikołowski, bieruńsko-lędziński oraz wodzisławski. Mikołowski and bierńsko-lędzieński districts are also located in the zone of influence of the Katowice-Pyrzowice Airport. They occupy similar positions in the rankings of the values of the projected features characterizing the distribution network in both areas of airports' influence. In the case of the X3 feature, apart from cities with district rights and provincial capital, these were units: krakowski, oświęcimski, wielicki, bielski. To sum up, it can be stated that most of the districts located only within the catchment area of the Rzeszów-Jasionka Airport are favorable in terms of infrastructural development. A different situation applies to units located in the zones of influence of the other two catchment areas. In addition, they are characterized by the volatility of positions occupied in the constructed rankings. We do not find publications in which technical infrastructure is analyzed in districts located in the zones of influence of airports in Poland. this makes it impossible to compare the obtained results with other studies. With the above in mind, it was only possible to make a local comparison.

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doi: 10.36689/uhk/hed/2023-01-062 HED Hradec Economic Days

Non-financial Reporting and Corporate Social Responsibility in the TOP Reporting Firms in the Czech Republic

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Abstract: Current non-financial reporting guidelines and new non-financial reporting directive are described and compared at the beginning of the article. The aim of the paper is to map and analyze non-financial and CSR reporting activities in the TOP Responsible Firms in reporting in the Czech Republic in 2022. The focus will be to the forms of reporting. The annual report, the individual CSR report and information at the www pages are the three basic reporting channels for publication. Additional criteria will be analysed in all three reporting options. The analysis showed that only four companies use all three channels for reporting. The best in the reporting are two commercial banks, Accenture Central Europe B.V. and ČEZ Group. They report about CSR in the annual reports, in special reports and on www pages. All of the analyzed companies report according to regulations in law and more detailed data.

Keywords: corporate social responsibility; non-financial reporting; reports

JEL Classification: M14; M40; M21

1. Introduction

The book Social Responsibilities of the Businessman in 1953 by Howard R. Bowen started the new era of Corporate Social Responsibility (CSR), or social responsibility as it was often called. Bowen's work (Bowen, 1953) proceeded from the belief that the several hundred largest businesses in the United States were vital centres of power and decision-making and that the actions of these companies touched the lives of citizens in many ways. Bowen asked the key question that continues to be asked today was "what responsibilities to society may businessmen reasonably be expected to assume?" Bowen for the first time tried to define the term CSR as acting as desired in the light of the goals and values of our society.

Archie B. Carroll defined in the year 1979 four basic areas of CSR, which until then had been considered contradictory. It was considered as a turning point. CSR is about:

- economic responsibilities,
- legal liabilities,
- ethical responsibilities,
- discretionary responsibilities (Carroll, 1979).

The World Business Council for Sustainable Development (1999) defines Corporate Social Responsibility as the “continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large”.

The European Commission (2023a) defines CSR as the responsibility of enterprises for their impact on society and, therefore, it should be company led. Companies can become socially responsible by integrating social, environmental, ethical, consumer, and human rights concerns into their business strategy and operations and following the law. Public authorities play a supporting role through voluntary policy measures and, where necessary, complementary regulation.

Accounting researchers have become increasingly interested in CSR, which has received notable attention in accounting and finance. Traditionally, CSR integrates business and social activities. Moser and Martin (2012) point out that companies engage in socially responsible activities when they conduct business activities.

Moravcikova et al. (2015) presented that CSR is a trend that appeals to a change of business orientation from short-term to long-term goals and from maximum to optimum profit. CSR reports, respectively triple-bottom-line reports have become tools of communication for Corporate Social Responsibility.

Despite a large number of definitions and their differences in interpretation, the authors agree that a company is part of society and cannot operate in complete isolation from the outside world. Definitions are usually interpreted in general terms, so any company can follow them, regardless of its size, legal form and the subject of business. Currently, however, large companies are reporting in the Czech Republic. This is due to legislation, but also to the fact that they have more resources or workers who deal with the given issue.

2. Non-Financial Reporting

Non-financial reporting, put simply, is a form of transparency reporting where businesses formally disclose certain information not related to their finances, including information on human rights. It helps organisations to measure, understand and communicate their human rights impacts, as well as set goals, and manage change more effectively. (National Action Plans on Business and Human Rights, 2023)

Sustainability and non-financial information have become a central concern among business leaders, investors, consumers and regulators. Capital market participants are increasingly prioritizing the importance of non-financial information. Investors, regulators and banks are looking for more standardization to drive accountability and include non-financial drivers in ratings, regulations and covenants. (Deloitte, 2021)

Non-financial reporting demonstrates, measures, and evaluates the organisation's performance in terms of fulfilling the strategy and goals of sustainable development. Especially for large companies, reporting is increasingly common and takes many forms: CSR report, report on sustainable development, ESG report or non-financial report. It is basically the same thing. In the future, an increase in regulation and increased pressure on companies to create these non-financial reports are expected. Starting non-financial reporting earlier

than the state mandate means gaining an advantage, becoming a leader in this area and avoiding hasty implementation mistakes when reporting becomes mandatory for companies. (Business Leaders Forum, 2023).

Companies are required to prepare an annual report if their financial statements are subject to audit. The information that the annual report must contain is given in Section 21 of Act No. 563/1991 Coll., on Accounting (Accounting Act).

2.1. Current Non-Financial Reporting Guidelines (NFRD)

Effective from the accounting period starting in 2017, new obligations to provide so-called non-financial information are established. This obligation is currently stipulated in the eighth part of the Accounting Act (32f to § 32i) and concerns:

- a large accounting entity, which is a commercial company and also a subject of public interest, if the average number of employees during the accounting period exceeds 500 as of the balance sheet date,
- consolidating accounting units of a large group of accounting units that are simultaneously a subject of public interest, if the average number of employees during the accounting period exceeds 500 on the balance sheet date.

According to the eighth part of the Accounting Act § 32g, an accounting entity submitting non-financial information shall disclose this non-financial information to the extent necessary to understand the development of the accounting entity, its performance and the effects of its activity. It is non-financial information concerning at least the following questions:

- the environment,
- social and employment,
- respecting human rights and
- fight against corruption and bribery.

2.2. New Non-Financial Reporting Directive

Specifically, on April 21, 2021, the European Commission presented the first draft of the Corporate Sustainability Reporting Directive (CSRD) regulating the obligation of companies to report sustainability-related data. This directive should replace the current Non-Financial Reporting Directive (NFRD) from 2014, which defines the requirements for reporting non-financial data, such as social and employment issues or a company's environmental impact. The current directive on non-financial reporting imposes the obligation to report only on a certain limited number of large companies, and the new proposal extends it to all large companies. Specifically, these are companies that meet one of the following conditions:

- employ more than 250 people and whose annual turnover exceeds 50 million euros,
- their annual balance sheet total exceeds 43 million euros,
- are publicly traded companies.

At the same time, it is now also possible to report non-financial data at the group level, so many companies are reported by a foreign parent group, which will also change with the implementation of the CSRD. Furthermore, the new directive will be supplemented with a list of specific indicators that companies must report and will have a uniform reporting methodology. The requirements for non-financial reporting have so far been defined very generally, and the European Union has in the past only published non-binding recommendations containing suggested indicators. The new version envisages the establishment of specific uniform indicators, which will also be specific to individual industries, which will enable easier comparison of companies in the framework of CSR.

These indicators will be developed by the European Financial Reporting Advisory Group (EFRAG), which also advises the European Commission when determining financial reporting rules. In the creation of standards, it will cooperate with important organizations in the field of non-financial reporting and will build the foundations on existing and frequently used standards defined within international initiatives, such as the Global Reporting Initiative (GRI), International Integrated Reporting Council (IIRC), Sustainability Accounting Standards Board (SASB) or Climate Disclosure Standards Board (CDSB). (PwC, 2021)

2.3. The Principle of Double Motherhood

The new directive orders companies to report on how their activities negatively or positively affect the environment and society, but at the same time they must also report on ESG (environmental, social and governance) risks and opportunities that may have a financial impact on society. This is called the principle of double motherhood. For companies, this principle means the introduction of an ESG risk management system, which includes, for example, risks associated with climate change. Companies will also be required to inform about how they have set up their strategy, goals and sustainability management system. (PwC, 2021).

2.4. Report as Part of the Annual Report

The new directive also aims to introduce the disclosure of all non-financial data in the context of strategy, thus not allowing companies to disclose their non-financial data in a separate document but to incorporate it into their annual report. Information about how companies affect the environment will thus formally reach the same level as the company's financial indicators. (PwC, 2021)

2.5. Audit of Non-Financial Reports

The ambitious goal of the European Commission is for the level of verification of non-financial information to equal the current level of financial auditing in the future. Due to the current absence of comprehensive uniform standards in this area, only their verification will be temporarily required, but the level of verification is planned to increase in the future. In addition, together with financial data, non-financial data will also be published in a machine-readable format in a European database (European Single Access Point - ESAP), which will bring greater transparency, easier benchmarking and analysis of non-financial data.

This new directive is expected to enter into force from the 2023 annual report, the directive is now at the beginning of the legislative process. If all plans were followed, this would mean that companies would have the first obligation to report in 2024 with data for 2023. The directive will then still need to be anchored in the new obligations of Czech law, but this should not slow down the effectiveness, since the Czech the republic will have to meet the timetable determined by the European Commission. (PwC, 2021)

3. Methodology

Statistics and results from competition TOP Responsible Firm in reporting in the Czech Republic in 2022 were used as the basis for analyzed companies. (Business for Society, 2022).

The article will deal with channels and how the companies inform about their Corporate Social Responsibility. Information on the firm's CSR activities was obtained from three basic sources. Annual reports from websites of the companies or from https://justice.cz/, separate published CSR reports or data about CSR from the official companies' websites were used. The data for 2021 became the subject of research because the annual reports and separate reports on corporate social responsibility for 2022 were not published by selected companies at the time of processing of the article. It is expected that since the companies entered the competition and placed in the first positions, they will be active in reporting.

4. TOP Responsible Firm in Reporting in the Czech Republic in 2022

TOP Responsible Firm is a prestigious independent award that annually highlights the most interesting activities in the field of sustainable and responsible business. The award is open to small and large companies that can submit their strategies and projects implemented at least in part of 2022. All companies operating in the Czech Republic that are not in liquidation or bankruptcy proceedings can apply for the prize. The location is not pretentious. Companies must truthfully fill in the required information about the company during registration and provide truthful information about the activities implemented in the field of sustainable and responsible business in the applications for individual categories.

Information about applied strategies and projects, as well as contact data (except for parts marked as intended for external communication) is considered by Business for Society to be sensitive data for the company and is not provided to any third parties without prior consent.

Strategies and projects can be applied to the award repeatedly and gradually reach higher levels of award. However, according to the rules of the award, it is not possible to repeatedly receive the highest award for the same strategy or project. For the winners of the individual categories, only the innovation and development of the strategy or project since the time the company was awarded will be the subject of evaluation. (Business for Society, 2022)

4.1. Methodology of Evaluation

Award for a company that comprehensively, transparently and effectively measures and communicates its activities in the area of responsible and sustainable business. It is possible to submit a report on social responsibility / sustainable development published by July 18, 2022, covering the period of 2021.

The award will be given to a company that appropriately chooses areas and indicators for sustainable development reporting, connects them to the global development goals (SDGs), effectively sets up and manages the non-financial reporting process, and processes the data obtained into transparent results that it communicates in a clear manner in available places.

The submitted reports will be evaluated and the winning reports will be determined on the basis of a point evaluation by an expert jury consisting of experts from the state administration, the commercial sector, the media and academia, as well as important personalities who are actively involved in the development of sustainable business in the Czech Republic (Business for Society, 2022).

4.2. Results

Award for a company that measures and communicates its activities in the area of responsible and sustainable business is presented in Table 1. The title will be awarded to all reports that receive at least 80% of the total evaluation.

Table 1. Business for Society TOP responsible business in reporting in the Czech Republic 2022 (Business for Society, 2022)

Company	Rating (in %)	Completeness	Credibility	Communication
Plzeňský Prazdroj, a.s.	87.9	89.4	84.7	91.9
PwC Česká republika	86.0	92.8	80.0	88.1
Vodafone Czech Republic, a.s.	84.7	91.1	79.6	85.9
MONETA Money Bank, a.s.	82.5	93.9	77.3	77.0
Accenture Central Europe B.V.	81.1	83.3	75.3	88.9
Coca-Cola HBC Česko a Slovensko, s.r.o.	80.9	91.1	79.2	70.4
Komerční banka	80.4	89.4	75.7	77.0
ČEZ Group	80.2	84.4	80.4	74.1

The winners are companies from several sectors. They are well known by the Czech citizens. Plzeňský prazdroj is producer of beer. PwC focuses on audit, taxes, accounting, law or consultancy. They focus on ESG education and capacity building (PwC, 2023). They educate clients in the field of ESG and thus respond to the challenges that the topic of social and environmental responsibility brings. PwC has also done Czech ESG Survey (2022). Three quarters of companies already have an ESG strategy or are currently working on one. It may come as a surprise that eight out of ten companies perceive the contribution of ESG positively. In the research were involved 122 companies. 48 were small, 38 middle and 33 large companies. Vodafone Czech Republic is telecommunications company. Moneta Money Bank and Komerční banka are the commercial banks. Coca-Cola HBC produces non-alcoholic drinks. ČEZ Group focus on the energies. Only Accenture Central Europe B.V. is not often presented name of the company.

The best evaluation gain eight best companies from Completeness (almost 90% in average). From Credibility they gain 79% in average and Communication 82% in average.

5. Results of Reporting Methods

The following tables summarize the results of the reporting methods on non-financial information in the analyzed companies.

5.1. Reporting Methods

Table 2 provides the results of an analysis that focuses on how individual companies report about CSR activities. Research focused on annual reports that will be used in future for presentation of CSR activities, whether they prepare a separate CSR report or provide information on their websites.

Table 2. Analysis of the method of reporting on CSR activities

Name of the company	Annual report	The CSR report	www pages
Plzeňský Prazdroj, a.s.	NO	YES	YES
PwC Česká republika	NO	YES	YES
Vodafone Czech Republic, a.s.	NO	YES	YES
MONETA Money Bank, a.s.	YES	YES	YES
Accenture Central Europe B.V.	YES	YES	YES
Coca-Cola HBC Česko a Slovensko, s.r.o.	NO	YES	YES
Komerční banka	YES	YES	YES
ČEZ Group	YES	YES	YES

- Only 4 companies publish information on CSR activities in the annual report. Two of them were banks.
- All companies prepare a separate CSR report.
- All analyzed companies address the topic of CSR or sustainability on their websites. The information and reports are done in the graphical way.
- Only 4 out of 8 companies provide CSR information in all ways.

5.2. Annual Report

Table 3 presents the results of analysis of annual reports for 2021 and 2017 where the new methodology of presentation of non-financial information was by legislation set. The table also provides data on the number of pages, graphic processing in 2021 (whether there are only text and tables or more data in the better graphic processing), the scope of the CSR part in 2021 and the regularity of the published CSR information in the annual report.

Table 3. Analysis of annual reports

Name of the company	Range in 2021	Range in 2017	Graphic processing	Scope of the section on CSR	Regularity of publishing CSR activities
Plzeňský Prazdroj, a.s.	47 p.	45 p.	NO	N/A	
PwC Česká republika	24 p.	22 p.	NO	N/A	
Vodafone Czech Republic, a.s.	47 p.	36 p.	YES	N/A	
MONETA Money Bank, a.s.	360 p.	308 p.	YES	2 p.	annually since 2016
Accenture Central Europe B.V.	50 p.	40 p.	NO	1 p.	annually since 2014
Coca-Cola HBC Česko a Slovensko, s.r.o.	32 p.	28 p.	NO	N/A	
Komerční banka	337 p.	286 p.	YES	10 p.	annually since 2004
ČEZ Group	369 p.	356 p.	YES	5 p.	since 2020

- The range of annual reports ranges from 24 to 369 pages in 2021.
- The annual reports of commercial banks are each year prepared in the more precise and detailed way. Also, ČEZ Group has nice detailed report. For the next analyzed companies there were no found such big changes.
- The number of pages of the CSR part ranges from 0 to 10 pages.
- Komerční banka has the longest part of CSR and has the longest regularity of publishing CSR activities.
- Accenture Central Europe is reporting about Sustainability and Governance.
- ČEZ Group wrote about climate and environment in all reports, but about CEZ Group's mission and social responsibility and ESG (environmental, social and corporate governance) is publishing since 2020 in the annual report.

5.3. CSR Report

Table 4 provides information on the number of pages, graphics design and the publication interval, including the implementation of the first report.

Table 4. Analysis of individual CSR reports

Name of the company	Range in 2021	Range in 2017	Graphic processing	Regularity of publishing CSR activities
Plzeňský Prazdroj, a.s.	75 p.	Only www	YES	annually since 2006
PwC Česká republika	45 p.	N/A	YES	annually since 2019
Vodafone Czech Republic, a.s.	87 p.	36 p.	YES	annually since 2008
MONETA Money Bank, a.s.	92 p.	20 p.	YES	annually since 2017
Accenture Central Europe B.V.	51 p.	N/A	YES	N/A
Coca-Cola HBC Česko a Slovensko, s.r.o.	254 p.	26 p.	YES	annually since 2007
Komerční banka	95 p.	25 p.	YES	annually since 2017
ČEZ Group	102 p.	102 p.	YES	annually since 2016

- As with the annual reports, CSR reports evolve over time and the reports contain more information and are more graphically processed.
- The analysis showed that all companies prepare a separate report on CSR.
- The content of these reports is an introductory word, basic information about the company, CSR strategies and an analysis of individual areas.
- Coca-Cola HBC report for 2021 year is not only for the Czech Republic. The report for the Czech Republic is presented only on www pages.

5.4. WWW Pages

Web pages contains information about CSR in the shorter way than CSR reports. All materials are graphical processed and contains information about economic, social and environmental aspects. Several contains more information (philanthropic, ethical, legal etc.). It is easy to find information about CSR in all companies.

6. Discussion

Despite the absence of legislative requirements or standards for CSR Jain et al. (2015) finds that CSR reporting continued to improve in quality and quantity in the region on a

purely voluntary basis. The similar situation is also in the Czech Republic. If we compare not only the number of pages, but also the processing and content of reports in the Czech Republic, there is a significant shift in the more detailed and precise processing of CSR information and activities.

MacGregor Pelikánová (2019) focused on CSR information in annual reports in the EU. She focused on the 10 largest Czech companies in 2013-2017 that are subjects of the legal duty to prepare and submit e-file with the Commercial Register their annual reports. It appears that, at the minimum, large Czech businesses satisfy their legal duty and e-report on CSR to a similar extent, but in a dramatically different quality. Employee matters and adherence to international standards are used as a public declaration to society more than the data on environmental protection, while social matters and research and development are played down. A similar analysis was performed in the Czech automotive sector, that has lower level of reporting in the selected areas (Svobodová & Bednarska-Olejniczak, 2021) or in the banking sector (Svobodová et al., 2022) where the reports are well processed in the graphical design and also in content.

Nazir et al. (2022) published that the empirical outcomes reveal that ESG performance is positively associated with both measures of the cost of capital i.e., cost of equity and cost of debt. It suggests that socially responsible top global technology leaders bear a higher cost of capital as investors perceive ESG as an additional financial burden and do not treat ESG costs as a value-added factor.

Evaluation of cluster initiatives that can be used also in CSR is presented in Bureš et al. (2012). Hedvičáková and Král (2021) proposes a new framework for the performance evaluation of the manufacturing industry, which is based on the composite performance indicator. They also worked with clusters. Hálek et al. (2020) describes the importance and the use of the non-financial indicators and define the future development in the non-financial indicators. Chulkov et al. (2023) examined the relationship between CSR and measures of financial reporting quality. Empirical results demonstrate that firms with higher CSR scores are associated with higher accuracy of financial forecasts, fewer earnings surprises and greater coverage by financial analysts. This positive relationship is more profound for firms that face low agency concerns, firms that have a higher level of customer awareness, firms that have more long-term institutional ownership or firms that do not face financial constraints. Mikulecký et al. (2011) focused on Ambient environment and its properties and abilities. Accenture (2023) presented next point of view "Sustainability is the new digital".

7. Conclusions

On 5 January 2023 the CSRD entered into force. This new directive modernises and strengthens the rules about the social and environmental information that companies have to report. A broader set of large companies, as well as listed SMEs, will now be required to report on sustainability – approximately 50,000 companies in total. (European Commission, 2023b).

For many companies, changes in the legislation will mean a significant transformation that will require a lot of time and resources. In the business sphere, the issue of the environmental field, i.e. how companies behave towards the environment, is the most

focused, and the above-mentioned planned goal of the European Union to achieve carbon neutrality is proof of this. "According to the carbon footprint, it will be determined how much each product burdens the environment on its way from the production itself to the final disposal, and will be evaluated accordingly. Whoever has a higher carbon footprint will be at a disadvantage, for example financially."

For all the reasons mentioned above, non-financial reporting will become an integral part of the investor evaluation of every company. The largest companies, such as car companies, energy groups and arms manufacturers, already encounter CSR in their daily business. However, as a result of pressure from the European Union, the main engine of the described changes became financial institutions, which are supposed to favour sustainable projects when providing services in the form of loans. The God-loving activities of companies, which in the past were often just green-lacquered marketing without a deeper strategy, are therefore finally beginning to turn to concrete plans with clearly defined goals (Strouhal, 2022).

For small and medium-sized publicly traded companies, the effectiveness of the CSRD will be delayed by three years, but the European Commission also proposes the introduction of voluntary standards for small and medium-sized companies, as it is aware that even small and medium-sized companies must increasingly report non-financial data, for example to large companies that want to have a mapped supply chain or banks when applying for loans. The European Commission wants to provide guidance to smaller companies, otherwise they will be at risk of being removed from the supply chain and replaced by more responsible competition, which as a result positively supports the expansion of the entire CSR or ESG concept.

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doi: 10.36689/uhk/hed/2023-01-063 HED Hradec Economic Days

Trends in Environmental Protection Expenditure in Poland

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Abstract: The paper presents trends in environmental protection expenditure in Poland in selected years – from 2005 to 2020. It examines the structure and dynamics of the expenditure. The study shows that households have the largest share in the total amount of environmental protection expenditure in Poland, followed by investment expenditure on fixed assets (a much smaller share) and current costs of environmental protection (the smallest share). It was found that environmental protection expenditure in Poland is growing but is subject to periodical multidirectional fluctuations as reflected by the polynomial trend lines and the corresponding equations. The study also presents that the total gross costs of environmental protection in Poland increased in the study period due to macroeconomic and microeconomic effects – mainly inflation and rising operating costs of companies. Only the costs of research and development decreased.

Keywords: expenditure; environmental protection; Poland

JEL Classification: P28; R41; Q53

1. Introduction

Environmental protection expenditure comprises investment expenditure (on fixed assets and other outlays), net current costs, and household expenditure on environmental protection, pollution reduction, and remediation of environmental damage. Environmental expenditure does not include expenditure whose main purpose is to satisfy other needs, such as profit growth, occupational health and safety, and improved production efficiency, despite the fact that they may have a beneficial effect on the environment (Ekonomiczne aspekty ochrony środowiska, 2021).

The Polish Environmental Protection Act in force defines the meaning of the term, "environmental protection". It states that environmental protection is any act or omission that makes it possible to maintain or restore the balance of nature. The examples of environmental protection measures are given below:

- Efficient environmental development and the management of environmental resources in accordance with the principle of sustainable development;
- Anti-pollution measures;
- Restoration of natural elements to their proper status (Act no. 62/2001 item 627).

Some researchers, including Ciechanowicz-McLean, emphasize that the development of environmental regulations takes place in two stages. The first stage is associated with a variety of environmental regulations while the second stage marks the emergence of new legal institutions, e.g., liability for environmental damage. Legal institutions interrelate and merge into a whole to form environmental law (Ciechanowicz-McLean, 2021).

According to the Environmental Protection Act, sustainable development is the social and economic development that integrates political, economic, and social activities while maintaining the balance of nature and sustainability of basic natural processes to ensure that basic needs of particular communities or citizens of both the present and future generations can be satisfied (Act no. 62/2001 item 627).

The issue of sustainability is widely discussed in the literature, including by researchers such as Becla, Borys, Czaja, Fiedor, Graczyk, Poskrobko, Poskrobko, and Zielińska (Becla et al., 2014; Czaja et al., 2002; Borys, 2005; Poskrobko & Poskrobko, 2012; Zielińska, 2013).

The aim of the study is to analyse the structure and dynamics of environmental protection expenditure in Poland and present factors that influence changes in environmental protection expenditure. The study covers the years between 2005 and 2020.

2. Methodology and Data Sources

The study applies desk research, including descriptive, analytical, and mathematical statistical methods (using Excel). The paper incorporates selected items from the literature, specialised studies, and data from general statistics published in the yearbooks "Economic Aspects of Environmental Protection" and "Environmental Protection". The usage of high degree polynomials is only for the purpose of approximating the development within a certain time by polynomial regression. The trend line curves are not intended to be used for prediction.

3. Structure and Dynamics of Environmental Expenditure

Households have the relatively largest share in environmental protection expenditure in Poland. In the period from 2005 to 2020, they accounted for 63.5% of total environmental protection expenditure on average. The share of investment expenditure (on fixed assets) incurred by the whole Polish economy (excluding households) is much smaller (21%) and the share of current costs of environmental protection is the smallest (15.6%) (Figure 1).

Environmental protection expenditure in Poland is growing. In the period from 2005 to 2020, the expenditure increased to PLN 75.6 billion (2-fold compared to 2015). However, it was subject to periodical multidirectional fluctuations as reflected in the polynomial trend line (Figure 2) and the corresponding equation below.

$$y = 0.168x6 - 4.4466x5 + 45.464x4 - 225.54x3 + 560.1x2 - 646.02x + 309.04; \quad R2 = 0.09855 \tag{1}$$

Households generated the relatively most dynamic increase in environmental protection expenditure (PLN 51.5 billion in 2020, almost 2.4-fold compared to 2005). Investment expenditure (on fixed assets), and current costs of environmental protection increased much less dynamically, i.e., to PLN 11.4 billion (1.9-fold) and to PLN 12.6 billion (1.3-fold), respectively (Figure 2).

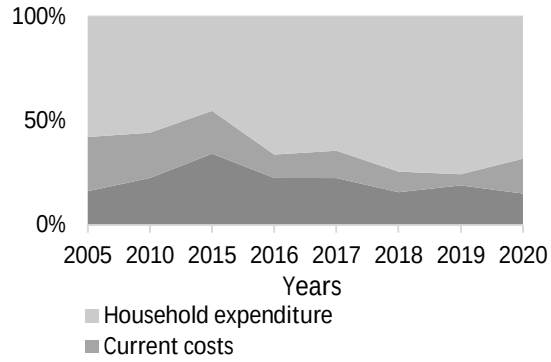

Figure 1. Structure of environmental protection expenditure in Poland in selected years – from 2005 to 2020 (%). Internal analysis (Ochrona środowiska, 2006–2018; Ekonomiczne aspekty ochrony środowiska, 2019–2021).

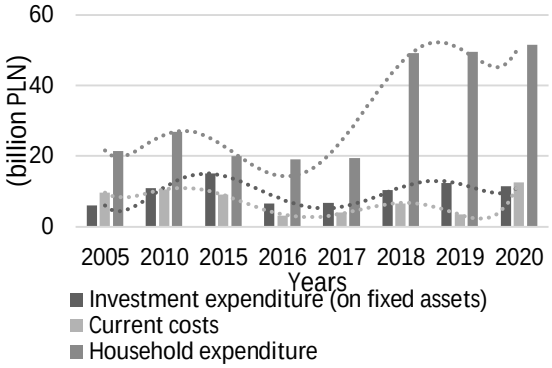

Figure 2. Environmental protection expenditure in Poland in selected years – from 2005 to 2020 (billion PLN). Internal analysis (Ochrona środowiska, 2006–2018; Ekonomiczne aspekty ochrony środowiska, 2019–2021).

The periodic fluctuations that occurred for the studied values were the rationale for presenting the 6th degree polynomial trend lines due to the coefficient of determination (R2) reflecting a goodness of fit of the regression function to the empirical data (Ostasiewicz et al., 2006). The polynomial trend line equations in Poland for the period from 2005 to 2020 are following. (2) For household environmental protection expenditure, (3) for investment expenditure (on fixed assets) and (4) for current costs of environmental protection.

$$y = 0.0836x^6 - 2.1945x^5 + 22.139x^4 - 107.66x^3 + 261.07x^2 - 294.45x + 142.54; \quad R^2 = 0.9597 \tag{2}$$

$$y = 0.0448x^6 - 1.2282x^5 + 13.078x^4 - 67.856x^3 + 176.11x^2 - 209.47x + 96.927; \quad R^2 = 0.9468 \tag{3}$$

$$y = 0.0397x^6 - 1.0239x^5 + 10.247x^4 - 50.026x^3 + 122.91x^2 - 142.1x + 69.57; \quad R^2 = 0.9973 \tag{4}$$

4. Household Environmental Protection Expenditure

Households are considered by analysts to be a specific group of ultimate consumers in environmental protection. On the one hand, they are buyers of environmental protection services, such as sewage disposal or domestic waste disposal. On the other hand, they are consumers of environment-related products specially designed to protect the environment, e.g., domestic wastewater treatment plants. Note that the household sector, unlike other sectors of the economy, does not differentiate between investment expenditure and current costs of environmental protection. Due the specific character of this sector, all outlays are taken jointly into account.

Household environmental protection expenditure includes the following expenses: (1) paid dues of households for environmental protection services, e.g., domestic sewage disposal); and (2) expenses related to the purchase, installation, and construction of equipment and products specially designed to protect the environment, e.g., domestic

wastewater treatment plants. This does not include expenditure whose main purpose is to meet other needs, not related to environmental protection, e.g., to meet the economic needs of households, even if it has a beneficial effect on the environment (Ekonomiczne aspekty ochrony środowiska, 2021).

The analysis of the data for selected years between 2005 and 2020 shows that expenditure on environment-related products have a slightly higher share of household environmental protection expenditure than expenditure on environmental protection services (54.4% and 45.6% per year on average, respectively) (Figure 3).

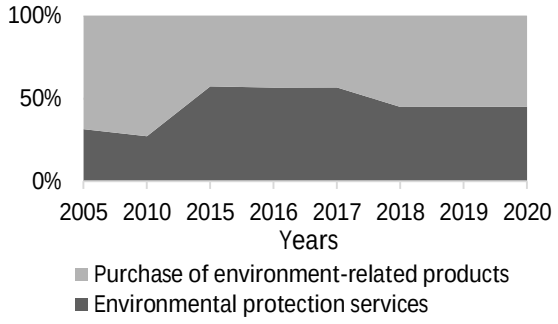

Figure 3. Structure of household environmental protection expenditure in Poland in selected years from 2005 to 2020 (%). Internal analysis (Ochrona środowiska, 2006–2018; Ekonomiczne aspekty ochrony środowiska, 2019–2021).

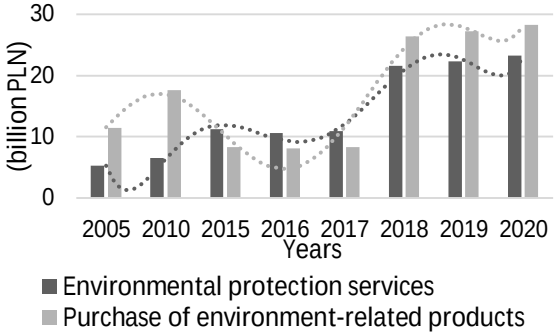

Figure 4. Household environmental protection expenditure in Poland in selected years – from 2005 to 2020 (billion PLN). Internal analysis (Ochrona środowiska, 2006–2018; Ekonomiczne aspekty ochrony środowiska, 2019–2021).

Over the study period, there has been an increase in the household expenditure on both environmental protection services and on the purchase, installation, and construction of equipment and products specially designed to protect the environment (environment-related products) in Poland (Figure 4).

In the period from 2005 to 2020, expenditure on environmental protection services and expenditure on the purchase, installation, and construction of equipment and products specially designed to protect the environment (environment-related products) increased to PLN 23.2 billion and PLN 28.3 billion in 2020 (4.4-fold and 2.5-fold compared to 2005), respectively. However, it was subject to periodical multidirectional fluctuations as reflected in the polynomial trend lines (Figure 4) and the following corresponding equations. The polynomial trend line equations in Poland for the period from 2005 to 2020 are following. (5) For household expenditure on environmental protection services and (6) for household expenditure on the purchase of environment-related products.

$$y = 0.0498x^6 - 1.3618x^5 + 14.529x^4 - 76.294x^3 + 204.36x^2 - 256.87x + 120.91; \quad (5)$$

$$R^2 = 0.9894$$

$$y = 0.032x^6 - 0.7979x^5 + 7.3956x^4 - 31.097x^3 + 57.855x^2 - 38.756x + 16.962; \quad (6)$$

$$R^2 = 0.9478$$

In 2018, there was a sharp increase in this expenditure, as compared to the previous year. Household expenditure on environmental protection services increased almost 2-fold (to PLN 21.6 billion) while expenditure on the purchase of environment-related products grew

even more dynamically, 3.2-fold (to PLN 26.4 billion). The changes in household expenditure on environmental protection services are due to an increase in the prices of drinking water supply, domestic sewage discharge, and municipal waste collection (Ceny w gospodarce narodowej, 2006–2020). The increase in expenditure on the purchase of environment-related products coincide with Polish air protection programmes, including municipal programmes, such as Clean Air (a nationwide programme) and Kawka Plus (a programme for the inhabitants of the city of Wrocław). Households are encouraged to take advantage of them and increasingly do (Program Czyste Powietrze, 2022; Zmień piec, 2022). According to available information, Kawka Plus has contributed to the replacement of more than 11,500 furnaces by Wrocław residents so far. However, many furnaces still need to be replaced. The furnace replacement may be hindered by the inflation allowance, i.e., one of the elements of the Anti-Inflation Shield enacted by the Parliament of the Republic of Poland at the beginning of 2022. It was announced in the Journal of Laws at the beginning of August 2022 as part of the Coal Allowance Act governing the procedures for granting, paying, and determining the amount of the coal allowance (Act no. 2022 item 1692). Some consumers may not be interested in replacing their coal-fired furnaces for economic reasons (coal allowance).

From 1 July 2024, the use of out-of-class (black-smoke-belching) and the lowest class furnaces will be banned in Wroclaw (Sejmowy dodatek osłonowy: dostaniesz więcej, jeżeli… palisz węglem, 2022). The situation in other large Polish cities is similar; they are actively involved in fighting emissions. By contrast, small towns, especially health resorts, have made little progress in the fight against smog. The averagely lower environmental awareness of inhabitants of small towns is compounded by lower-income problems. For example, replacing a coal-burning furnace with a gas-burning furnace requires an initial financial contribution by investors.

5. Investment Expenditure (on Fixed Assets) for Environmental Protection

Investment expenditure for environmental protection comprises expenditure on fixed assets and other expenditure for environmental protection. It includes financial and in-kind expenditure related to environmental protection. It is intended to create new fixed assets or improve (redevelop, extend, reconstruct, adapt, or modernise) existing fixed assets. Investment expenditure also includes expenditure on the so-called initial equipment for the investment.

Expenditure on fixed assets for environmental protection includes expenditure incurred, inter alia, on the following assets: (1) acquisition of land, including the right of perpetual usufruct of land; (2) buildings, premises, and civil engineering structures, including construction and assembly works as well as design and cost documentation; (3) machines and equipment; (4) means of transport; (5) tools, devices, movables, and equipment; (6) other fixed assets intended for protection.

Expenditure on fixed assets for environmental protection also includes expenditure incurred on (a) improvements to environmental-protection fixed assets (redevelopment, extension, modernisation, or reconstruction); and (b) research and development (Ekonomiczne aspekty ochrony środowiska, 2021).

Water management investments include the construction of intakes for water extraction (including treatment facilities and main water supply and distribution networks), the construction of water quality control laboratories (including automatic water quality measurement stations), the construction of storage reservoirs (except for fire reservoirs and continuous buffer vessels), barrages, navigation dams, power dams, locks, and weirs, river engineering, development of streams, the construction of flood embankments, and the construction of pumping stations in collapses and depressions (Ekonomiczne aspekty ochrony środowiska, 2021).

With respect to investment expenditure (on fixed assets) incurred for environmental protection and water management (considered jointly) in Poland in the period from 2005 to 2020, expenditure on fixed assets for environmental protection prevailed (Figure 5).

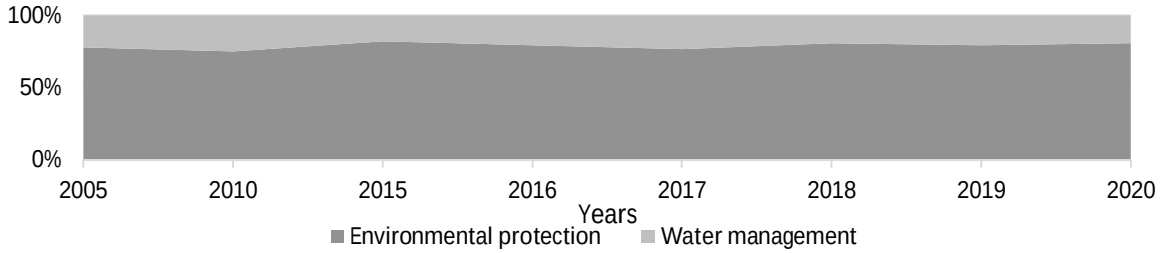

Figure 5. Structure of investment expenditure (on fixed assets) for environmental protection (environmental protection and water management considered jointly) in Poland in selected years from 2005 to 2020 (%). Internal analysis (Ochrona środowiska, 2006–2018; Ekonomiczne aspekty ochrony środowiska, 2019–2021).

The average annual share of this expenditure was 79.1%, with the remaining percentage going to investment expenditure allocated to fixed assets related to water management. The percentage distribution results from the need to improve sanitation, especially in rural areas (Ministerstwo Rolnictwa i Rozwoju Wsi, 2018; Ministerstwo Rolnictwa i Rozwoju Wsi, 2020).

Investment expenditure (on fixed assets) for environmental protection and water management in Poland is growing. Between 2005 and 2020, the expenditure for environmental protection increased more dynamically with regard to environmental protection than water management, i.e., to PLN 11.4 billion and PLN 2.7 billion in 2020 (1.9-fold and 1.6-fold compared to 2005), respectively (Figure 6).

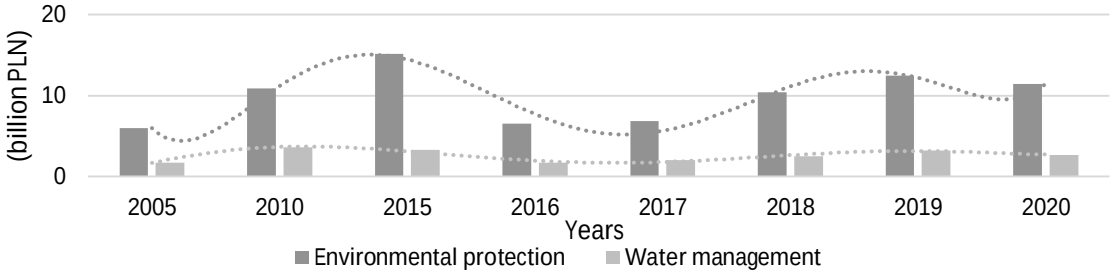

Figure 6. Investment expenditure (on fixed assets) for environmental protection and water management in Poland in selected years from 2005 to 2020 (billion PLN). Internal analysis (Ochrona środowiska, 2006–2018; Ekonomiczne aspekty ochrony środowiska, 2019–2021).

The periodic fluctuations that occurred for the studied values were the rationale for presenting the 6th degree polynomial trend lines due to the coefficient of determination (R2)

reflecting a goodness of fit of the regression function to the empirical data (Figure 6). The polynomial trend line equations in Poland for the period from 2005 to 2020 are following. (7) For investment expenditure (on fixed assets) for environmental protection and (8) for investment expenditure (on fixed assets) for water management.

$$y = 0.0444x^6 - 1.2236x^5 + 13.087x^4 - 68.259x^3 + 178.19x^2 - 212.77x + 96.892; \quad (7)$$
$$R^2 = 0.9465$$
$$y = 0.0024x^6 - 0.062x^5 + 0.5879x^4 - 2.3794x^3 + 3.1955x^2 + 1.9839x - 1.6363; \quad (8)$$
$$R^2 = 0.9441$$

Data on investment expenditure for environmental protection in Poland is presented in accordance with the Polish Statistical Classification regarding Environmental Protection Activities and Equipment. It was developed on the basis of the UN/ECE International Standard Statistical Classification of Environmental Activities and Equipment and the European System for the Collection of Economic Information on the Environment (SERIEE). The Classification of Environment Protection Activities and Expenditure (CEPA 2000, 2022) is used to compile data related to environmental protection. Environmental protection areas defined by CEPA include the following: (1) protection of ambient air and climate; (2) wastewater management and water protection; (3) waste management; (4) protection and restoration of the use value of soils, protection of ground and surface water; (5) reduction of noise and vibration; (6) protection of biodiversity and landscape; (7) protection against ionising radiation; (8) research and development; (9) other environmental protection measures, including, in particular, administration and management of the environment, education, and training (Act no. 25/1999 item 218).

The structure of expenditure on fixed assets for environmental protection in Poland is dominated alternately by expenditure on wastewater management and water protection and expenditure on ambient air and climate protection (Ekonomiczne aspekty ochrony środowiska, 2021). In the period from 2005 to 2020, expenditure on wastewater management and water protection accounted for between 35% and 66% of total expenditure on fixed assets for environmental protection, expenditure on ambient air and climate protection accounted for between 19% and 39%, and expenditure on waste management accounted for between 6% and 20%. The share of expenditure on research and development was also quite significant (between 3% and 10%). Out of the total expenditure on environmental protection in Poland in 2005–2020, the following percentages were allocated to the areas specified below: (1) reduction of noise and vibration (from 1% to 3%); (2) protection of soil, groundwater, and surface water (from 0.5% to 1.7%); (3) protection of biodiversity and landscape (from 0.1% to 2%); (4) other environmental protection measures, including, in particular, administration and management of the environment, education, and training (from less than 0.1% to 0.3%); protection against ionising radiation (to less than 0.1%); in some years, e.g., 2019–2020, no expenditure was incurred (Ekonomiczne aspekty ochrony środowiska, 2019-2021). On the whole, other areas of environmental protection had a relatively small share of expenditure.

The directions of expenditure on fixed assets for environmental protection in Poland result from the need to improve sanitation, especially in rural areas, as pointed out earlier in this study.

The overall increase in expenditure on fixed assets for environmental protection in Poland in the study period was influenced by the increase in expenditure in the following areas: protection of ambient air and climate (to PLN 3.74 billion in 2020, 3.3-fold compared to 2005); wastewater management and water protection (to PLN 5.53 billion, 1.5-fold); protection of soils, groundwater, and surface water (to PLN 0.2 billion, 2.2-fold); reduction of noise and vibration (to PLN 0.13 billion, 1.2-fold); protection of biodiversity and landscape (to PLN 0.2 billion, 28.6-fold); research and development (to PLN 0.005 billion, 12.5-fold); and other environmental protection activities (to PLN 0.91 billion, 4.6-fold). Expenditure on fixed assets for waste management slightly decreased (to PLN 0.74 billion, by 1.33%). There was no expenditure on protection against ionising radiation in 2020 (in 2005, it amounted to PLN 0.3 million and remained similar in subsequent years, until 2018). The material effects of environmental investments are shown in Table 1.

Table 1. Selected material effects achieved as a result of the commissioning of environmental investments in Poland from 2005 to 2020 (Ochrona środowiska, 2006–2018; Ekonomiczne aspekty ochrony środowiska, 2019–2021).

Item/Years	2005	2010	2015	2016	2017	2018	2019	2020
Number of wastewater treatment plants (pcs)	118	80	49	17	21	50	56	39
of which: - biological sewage treatment plants (pcs)	70	49	45	15	19	47	52	37
- with enhanced nutrient removal (pcs)	9	4	2	1	2	2	3	2
Landfills, tailing ponds, and dumps for industrial and municipal waste (ha)	53	24	14	19	9	9	24	20
Landfill site restoration (ha)	26	76	443	64	49	115	92	33
Sewage disposal system (km)	5,417	8,462	7,961	2,642	2,058	3,712	4,225	3,364
Rainwater drainage system (km)	352	837	866	457	506	605	633	593

In the period from 2005 to 2020, the following facilities were commissioned in Poland: 430 wastewater treatment plants, including 334 biological treatment plants and 25 plants with enhanced nutrient removal (the remaining plants include mechanical and chemical treatment plants); 172 hectares of landfills, tailing ponds, and dumps for industrial and municipal waste; 898 hectares of landfill sites (rehabilitation); 37.84 thousand km of sewage disposal system; 4,849 km of rainwater drainage system.

The effects of environmental protection measures are good but there is still much to be done.

6. Current Costs of Environmental Protection

Current costs of environmental protection include gross and net current costs. Gross current costs are the costs of operation and maintenance of environmental protection activities (technology, process, and equipment). Their main purpose is to prevent, reduce, neutralise, or eliminate pollution and any other environmental losses resulting from the

entity's current activities. They include the costs of in-house activities, including the costs of operation and maintenance of environmental protection equipment (end-of-pipe and pollution prevention measures) and the costs of services provided by external parties, service charges (for wastewater pollution and waste disposal), environmental charges, and the costs of inspection, monitoring, and laboratory testing.

Net current costs are gross current costs less revenues and savings achieved from the operation of protective equipment, subsidies received, and revenues for environmental services, including, in particular, wastewater treatment, waste transport, and waste disposal.

Current costs of environmental protection do not include: (1) the costs of health and safety measures; (2) the costs of water and forest management; (3) the costs of activities related to conservation of natural resources or energy savings – if their main purpose is other than environmental protection (Ekonomiczne aspekty ochrony środowiska, 2021).

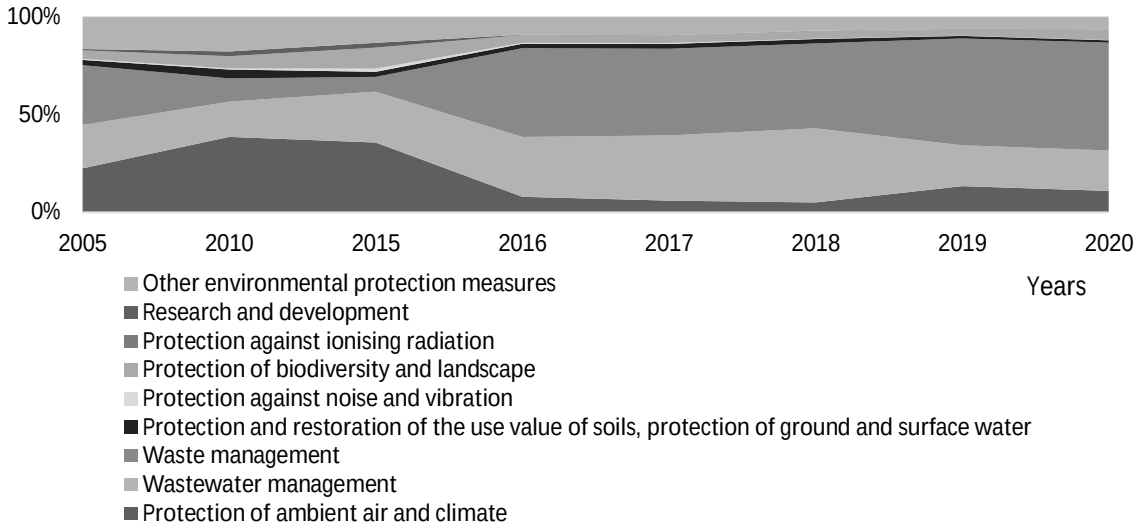

Figure 7. Structure of gross costs of environmental protection in Poland in selected years – from 2005 to 2020 (%). Internal analysis (Ochrona środowiska, 2006–2018; Ekonomiczne aspekty ochrony środowiska, 2019–2021).

The costs of waste management have the largest share of gross costs of environmental protection (36.7% of total costs incurred annually in the study period on average). They are followed by the costs of wastewater management (26.3%) and the costs of air and climate protection (17.5%). The following costs have much smaller share in the gross costs of environmental protection: other environmental protection activities (10.5%); protection of biodiversity and landscape (5.3%); protection and restoration of the use value of soils, protection of groundwater and surface water (2.4%); research and development (0.8%); protection against noise and vibration (0.5%); and protection against ionising radiation (0.04%) (Figure 7).

Environmental costs are growing. In 2020, the following costs increased as compared to 2005 (in descending order): waste management (14.3-fold, i.e., to PLN 41 billion); protection of biodiversity and landscape (10.3-fold, i.e., to PLN 4.1 billion); wastewater management (7.4 fold, i.e., to PLN 15.4 billion); air and climate protection (3.8-fold, i.e., to PLN 8.1 billion); protection and restoration of the use value of soils, protection of groundwater and surface

water (3.4-fold, i.e., to PLN 0.86 billion); other environmental protection activities (3-fold, i.e., to PLN 4.5 billion); protection against noise and vibration (1.6-fold, i.e., to PLN 0.08 billion); and protection against ionising radiation (1.3-fold, i.e., to PLN 0.01 billion). Only the costs of research and development decreased (by 38.7%, to PLN 0.04 billion) in the study period (Figure 8; Figure 9).

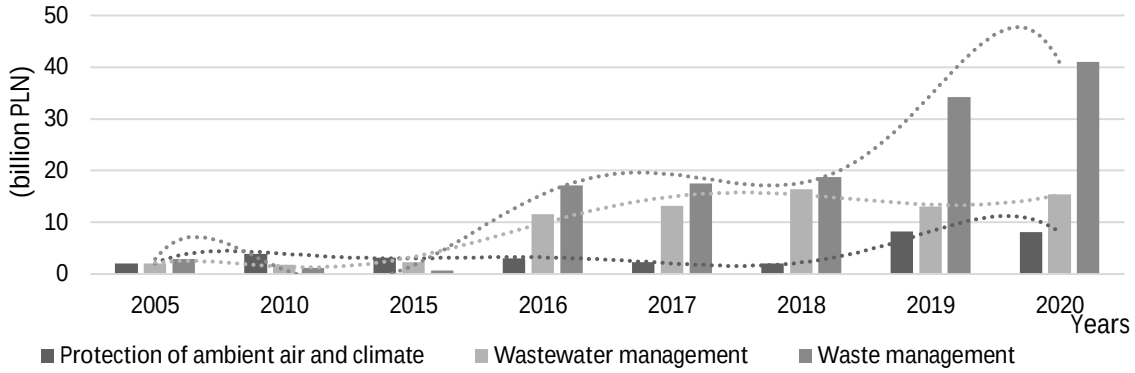

Figure 8. Gross costs of environmental protection in Poland with respect to ambient air and climate protection, wastewater management, and waste management in selected years – from 2005 to 2020 (%). Internal analysis (Ochrona środowiska, 2006–2018; Ekonomiczne aspekty ochrony środowiska, 2019–2021).

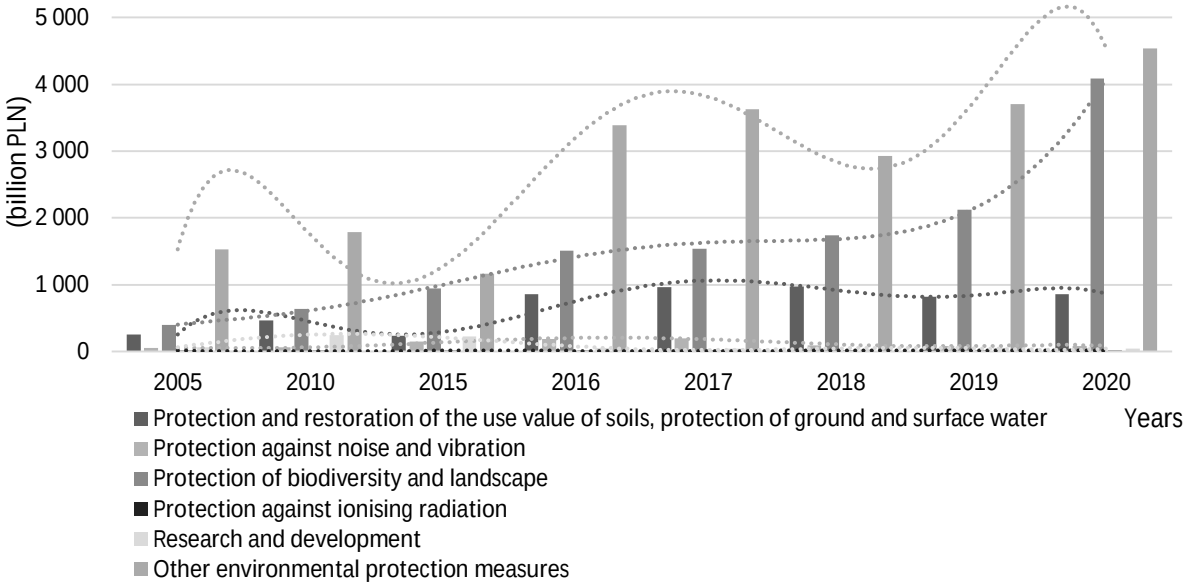

Figure 9. Gross costs of environmental protection in Poland with respect to protection and restoration of the use value of soils, protection of groundwater and surface water, protection of biodiversity and landscape, protection against noise and vibration, and protection against ionising radiation in selected years from 2005 to 2020 (%). Internal analysis (Ochrona środowiska, 2006–2018; Ekonomiczne aspekty ochrony środowiska, 2019–2021).

Due to periodic fluctuations in costs relating to ambient air and climate protection, wastewater management, waste management, protection and restoration of the use value of soils, groundwater and surface water protection, protection of biodiversity and landscape, protection against noise and vibration, protection against ionising radiation, research and

development, and other environmental protection activities (Figure 8; Figure 9) that occurred during the study period, the trend lines are presented as polynomial trend lines. The polynomial trend line equations for the corresponding types of costs are following. (9) Ambient air and climate protection, (10) wastewater management, (11) waste management, (12) protection and restoration of the use value of soils, protection of groundwater and surface water, (13) protection of biodiversity and landscape, (14) protection against noise and vibration, (15) protection against ionising radiation, (16) other environmental protection activities and (17) research and development.

$$y = -0.0206x^6 + 0.5267x^5 - 5.2826x^4 + 26.424x^3 - 69.063x^2 + 88.284x - 38.775;\ R^2 = 0.9966 \quad (9)$$

$$y = -0.0088x^6 + 0.2692x^5 - 3.1255x^4 + 17.163x^3 - 45.097x^2 + 53.537x – 20.588;\ R^2 = 0.9683 \quad (10)$$

$$y = -0.0919x6 + 2.422x5 - 24.817x4 + 124.52x3 - 315.51x2 + 375.75x – 159.32;\ R^2 = 0.9944 \quad (11)$$

$$y = -2.4817x^6 + 70.279x^5 – 778.47x^4 + 4244.2x^3 – 11752x^2 + 15389x – 6915.3;\ R^2 = 0.9579 \quad (12)$$

$$y = -0.2539x^6 + 8.66x^5 - 98.881x^4 + 492.54x^3 - 1101.7x^2 + 1302.4x – 202.95;\ R^2 = 0.9976 \quad (13)$$

$$y = -0.219x^6 + 5.5716x^5 - 53.062x^4 + 232.6x^3 - 471.7x^2 + 433.51x – 95.425;\ R^2 = 0.972 \quad (14)$$

$$y = 0.024x^6 - 0.6728x^5 + 7.5074x^4 - 42.146x^3 + 123.7x^2 – 175.82x + 98.412;\ R^2 = 0.9946 \quad (15)$$

$$y = -13.656x^6 + 372.15x^5 - 3954.5x^4 + 20651x^3 - 54775x^2 + 68621x – 29373;\ R^2 = 0.9908 \quad (16)$$

$$y = 0.2981x6 - 7.7444x5 + 75.355x4 - 330.69x3 + 591.55x2 – 180.2x – 86.075;\ R^2 = 0.977 \quad (17)$$

The increase in gross costs of environmental protection in Poland in the study period results from both macroeconomic and microeconomic effects. A further increase of these costs is expected, mainly due to the rising inflation, which is an unfavourable effect, and the growing costs of the functioning of enterprises carrying out environmental protection activities, such as waste collection, handling, and management, water supply, and wastewater collection and treatment.

7. Conclusion

The analysis of the data shows that households have the largest share in environmental protection expenditure in Poland. Investment expenditure (on fixed assets) for environmental protection and current costs of environmental protection have much smaller share. On the one hand, households are buyers of environmental protection services, such as sewage disposal or domestic waste disposal. On the other hand, they are consumers of environment-related products specially designed to protect the environment, e.g., domestic wastewater treatment plants.

The research reveals that environmental protection expenditure in Poland is growing. Households generated the relatively most dynamic increase in environmental protection expenditure. This is primarily due to an increase in the prices of domestic sewage and municipal waste collection as well as air protection programmes, including municipal programmes. Households benefit from the programmes by replacing old and inefficient solid fuel heat sources with modern sources that meet the highest standards and the improvement of the thermal efficiency of homes. Another factor that plays an important role is the growing environmental awareness of Polish society.

The analysis of the data also shows that the structure of expenditure on fixed assets for environmental protection in Poland is dominated alternately by expenditure on wastewater management and water protection and expenditure on ambient air and climate protection. This results from the national needs and the need to adjust to the requirements of the European Union.

Expenditure on fixed assets for environmental protection in Poland in 2005–2020 helped achieve specific goals. They include the commissioning of new wastewater treatment plants, including, in particular, biological sewage treatment plants and wastewater treatment plants with enhanced nutrient removal, new landfills, tailing ponds, and dumps for industrial and municipal waste, and a new sewage disposal and rainwater drainage system, and the rehabilitation of waste disposal areas. These developments are favourable, both in terms of environmental protection and for socio-economic reasons.

Furthermore, the analysis of the data shows that the total gross costs of environmental protection in Poland increased in the study period. In structural terms, virtually all types of costs increased, including costs covering the following areas: waste management, protection of biodiversity and landscape, wastewater management, air and climate protection, protection and restoration of the usable value of soils, protection of groundwater and surface water, other environmental protection activities, protection against noise and vibration, and protection against ionising radiation. Only the costs of research and development decreased. The increase in the costs is due to both macroeconomic (especially rising inflation) and microeconomic (rising operating costs of companies, e.g., waste management companies) effects.

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Differences in Attitude Towards Ethical Shopping between Generations X, Y and Z in a Marketing Communication Context

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Abstract: The need to ensure sustainable consumption is one of society's main challenges. The latest research agrees that current levels must change to achieve long-term sustainability. A prerequisite for sustainable development is sustainable consumption. Communication's role in promoting the purchase of environmentally friendly products is an important field of research in this area. The article aims to identify attitudes towards the ethical aspects of purchasing and their differences among Generation X, Y and Z representatives and use these findings in marketing communication. This information can aid in increasing consumers' awareness about ethical shopping principles. Different approaches were determined through research by the Department of Business and Finance at CZU Prague from 2014–2021, focusing on sustainable shopping and applying ethical principles when purchasing. The research comprises a quantitative questionnaire survey (n = 996) and a statistical data evaluation. It was found that the direct purchase of ethical products was most often carried out by Generation Z and the least by Generation X. When considering ethical values in a purchase decision-making process, Generation X prioritizes the desire to help, whereas Generation Y and Z prioritize the sense of personal responsibility. The Covid 19 pandemic had no major effect on the Generation's approaches.

Keywords: communication; consumption; ethics; generation; marketing; purchase; sustainability

JEL Classification: M31; O13; O44

1. Introduction

In order to correctly target marketing communication and utilise appropriate communication, it is important to understand the attitudes of today's consumers towards ethical shopping. Sustainable consumption is considered one of the main prerequisites for sustainable development (Barber, 2007; Bengtsson et al., 2018; Liu et al., 2017). The connection between ethics and sustainability, on the one hand, and the purchasing decisions of consumers, on the other hand, is evident in the group of people referred to as ethical consumers. These consumers feel responsible for the environment and society and try to express their values through consumption and purchase or, conversely, through targeted boycotts (Davies & Gutsche, 2016; Shaw & Newholm, 2002). Ethical consumers have political, religious, spiritual, environmental, social or other motives for their preference for one product over another. Promoting the purchase of organic products and the role of

communication for sustainable consumption are two important fields of research in this area (Araújo et al., 2021).

The current main obstacles to sustainable consumption include the high price of environmentally friendly products, lack of information and knowledge on the part of consumers, and a generally low level of environmental awareness (Han, 2020; Kreuzer et al., 2019; O'Connor et al., 2017; Han, 2020). Personal ethical attitudes and values often have limited influence on purchasing decisions (Govind et al., 2021). In some cases, consumers adopt ethical habits in their daily consumption, even if they have little interest in ethics or do not understand it. A frequent reason is the media coverage of negative consumption impacts on the environment.

The main goal of the article is to identify the attitudes towards ethical aspects of purchasing and their differences among representatives of Generations X, Y and Z and use these findings in marketing communication. In terms of communication with different generations of consumers, it was found that empirical research mapping the relationship between sustainable consumption and shoppers in the Czech Republic is limited. Therefore, the paper examines consumers' purchasing decisions regarding ethical aspects and suggests possible ways to address these segments. The study complements the current literature on examining the willingness and reasons to purchase or ignore so-called ethical products in relation to the intensity of their purchase. The research results can probably be used as default data to support targeted ethical purchasing.

2. Theoretical Part

Today's world is experiencing rapid and continuous growth in production and sales, which in turn is a driving force in the growth of global consumption. This causes significant damage to nature as it wastes natural resources and leads to climate change, among other things. Environmental issues have been increasingly discussed in recent years, and not only activists but also ordinary people have started to take an interest in them and talk about them. It is clear that consumers buy environmentally friendly products more often than ever before (Kisieliauskas & Jančaitis, 2022). Sustainable, ethical consumption becomes a phenomenon that influences the ethical decisions of other consumers by creating a culture of ethical consumption (Young, 2017). People are more likely to shop ethically if others around them do as well (Starr, 2009). The study by Davies and Gutsch (2016) also confirms that awareness and knowledge of sustainable and ethical principles are not high among consumers and that people often buy only under environmental pressure. The latest perspectives on sustainable consumption research emphasise the influence of the immediate environment. In this case, the role of citizens organising themselves for a more sustainable lifestyle with changes in individual values (Bachnik & Szumniak-Samolej, 2018; John et al., 2016; Schröder et al., 2019). It is necessary to consider that the problem of consumption is not limited to environmentally friendly products and environmental impacts but is also a social problem (Briceno & Stagl, 2006; Jaeger-Erben & Offenberger, 2014; Lorek & Spangenberg, 2014). Nevertheless, there is a discrepancy between attitudes and beliefs about ethical shopping and actual purchase intention (Nicholls & Lee, 2006). Ethical consumerism is a flourishing movement, but

ethically-minded consumers hardly ever shop ethically. Therefore, marketing communication tools can be utilised here very well.

Regarding individuals, ethics and perceptions of sustainability are the results of a process of moral development (Ma et al., 2012). This process can be influenced by the accumulated personal experience and situational factors that shape a person's behaviour. The Generational theory emphasises that the ethics and ethical values of an individual are strongly influenced by common political, social and historical events that were significant for a group of people born and living in a certain time period (VanMeter et al., 2012), the so-called generation. Each generation develops different personal and other values, potentially leading to differences in ethical values and behaviour. Differences in attitudes towards ethical issues among generations can be significant (Verschoor, 2013, Costanza & Finkelstein, 2015).

3. Methodology

The information presented in the article is based on research carried out by the Department of Business and Finance, Faculty of Economics and Management of the Czech University of Life Sciences Prague, which dealt with the issue of sustainable purchasing and the application of ethical principles when purchasing in the conditions of the Czech Republic between 2014 and 2021. The questionnaire survey was carried out in a manner that complied with ethical principles and the requirement of anonymity. A total of 5,324 respondents (aged 15–93) voluntarily answered the questionnaires in the monitored period. Data collection was conducted in collaboration with students within their extended family and network of friends through a combination of electronic and face-to-face interviews using Google Forms software. The questionnaire was divided into three parts, which contained a total of 40 questions. The questionnaire, including the wording of the questions, has been slightly modified over the years to adapt to areas of research interest. The questionnaire was distributed only in an electronic form using social networks. The research for 2020 and 2021 also took into account the impact of shopping on the environment, energy and water savings, buying organic food and the experience of shopping without packaging. In 2021, the extent of the impact of the Covid 19 pandemic on the change in the purchase of ethical products.

For the purposes of this contribution, data related to Generations X, Y and Z were utilised for statistical analysis of the results of a sample survey among the Czech Republic's population in 2021. Only respondents belonging to the given generation of consumers in terms of age were included. Generation X included respondents born between 1965–1980 (Kroth & Young, 2014), Generation Y (millennials) people born between 1982–1995 and the youngest Generation Z (commonly referred to as Gen Z) people born between 1996–2015 (Tahal, 2017). The total frequency of the analysed sample is 996, whilst the distribution of the number of respondents into individual generations is given in Table 1.

Table 1. Number of Generation X, Y and Z respondents in 2021 (number of persons in group)

X	Y	Z	total
274	484	238	996

For the purposes of the article, the following answers to questions from the questionnaire survey were analysed:

- to what extent respondents consider when purchasing whether they can benefit someone (e.g., non-profit organisation, fair-trade, charity, public benefit organisation),
- the extent to which respondents purchase ethical products,
- reasons why they buy or do not buy ethical products,
- where they most often acquire knowledge and information about ethical products,
- whether they boycott products or services, e.g., in the case of the use of child labour, violation of human rights, cruelty to animals,
- for what reasons they are willing to boycott products.

The results of the questionnaire survey were evaluated using absolute and relative frequencies of responses. The answers to selected questions from the questionnaire were then related to the age of the respondents.

The following research questions were specifically defined:

RQ1 Is there a significant difference among generations X, Y and Z when purchasing goods in terms of their interest in their origin?

RQ2 Is there a significant difference in the frequency of purchasing ethical products among generations X, Y and Z?

RQ3 Do YouTubers have a different influence on generations X, Y and Z when making consumer decisions about purchasing ethical products?

And based on them, the following specific statistical hypotheses were tested:

- H_{01}: Interest in the origin of goods does not depend on whether the consumer belongs to generations X, Y and Z.
- H_{02}: The frequency of buying ethical products does not depend on whether the consumer belongs to the X, Y and Z generations.
- H_{03}: The extent to which consumers are influenced by YouTubers when purchasing ethical products does not depend on the consumer's belonging to generations X, Y and Z.

Based on the analysis of contingency tables, the differences between Generations X, Y and Z were tested (the influence of the age factor was assessed). Statistically significant dependence of attitudes on age categories, or generations, was tested using Pearson's $\chi 2$-test. Statistical significance was set at $p < 0.05$. In the case of a proven statistically significant dependence, the strength of this dependence was measured and assessed using the Pearson contingency coefficient or Cramer's V. Based on the residuals, i.e., the differences between actual and theoretical frequencies in contingency tables, the contribution of the given combination of characters leading to the rejection of the null hypothesis (proving a statistically significant difference or the influence of the given factor) was then assessed. TIBCO Statistica 13.0.0.15 software for Windows was used for statistical analysis.

Thanks to ongoing and long-term research into the issue of sustainable shopping and the application of ethical principles when purchasing in the Czech Republic, it was possible to define recommendations on how to communicate in the context of ethical values. Based on

the analysis of survey data, consumer attitudes to the ethical aspects of shopping and their development in the 2014–2021 time horizon were identified. The results make it possible to define specific options and tools of communication so that it is possible to both increase customers' awareness of ethical shopping and, at the same time, convince them to buy ethical consumer goods.

4. Results

In order to properly target marketing communication and use appropriate communication tools, it is important to understand the attitudes of today's consumers of Generation X, Y and Z towards ethical shopping.

4.1. Differences in Attitude to Ethical Shopping between Generations X, Y and Z

According to the research carried out, the representatives of Generation X in the supermajority rather exceptionally or even randomly (56%) take into account when making a purchase whether they can benefit someone (e.g. a non-profit organisation, fair-trade, charity organisation, general benefit purpose), which is in comparison with other generations, the highest value found (Y 52%, Z 55%). 17% of people in Generation X, 13% and 14% in Generation Z do not pay attention to these aspects at all. In the case of the group of respondents of Generation Z (17%), the largest group of consumers was recorded who, on the other hand, try to benefit other organisations in a targeted way when purchasing (Generation X 9%, Generation Y 15%).

Table 2. Testing the significance of differences among generations X, Y and Z in the case of the aspect of trying to benefit someone else by purchasing

	Chi-square	SV	p
Pearson chi-square	14.0864	df = 6	p = 0.0287
M-V chi-square	14.5264	df = 6	p = 0.0243
Contingency coefficient	0.1181		
Cramer's V	0.0841		

As seen in Table 2 above, the aspect of trying to benefit someone else by purchasing (i.e., taking into account other ethical aspects in addition to the purchase itself), a statistically significant (p = 0.0287) weak dependence (C = 0.1181) on belonging to Generations X, Y and Z was demonstrated with 95% confidence. The results thus confirmed that significantly fewer people of Generation X answered "targeted", significantly fewer people of Generation Y "often", significantly more people of Generation Z "often".

Generation X consumers are characterised by the fact that they clearly buy ethical products with the least intensity. In this group, only 26% of people behave this way when purchasing and consider ethical aspects directly or often when making decisions. In Generation Z, it is 41%, and in Generation Y, it is 37% of people. The figure for people who do not shop in this way at all is also the highest, it is 14%. To some extent, the positive fact is that only 7% of representatives of group Y and 6% of representatives of group Z do not buy in this way at all, which is only a fractional part. So, there was a big difference in the behaviour of individual generations.

61% of Generation X and 57% of consumers of Generation Y buy ethical products and services only rarely or randomly. The actual purchase of products/services that can be described as "ethical" is also mostly limited in the group of respondents of the Generation Z. 53% of consumers prefer these products, either exceptionally or randomly. There is, therefore, quite a lot of room for improvement with the use of communication tools.

The Covid 19 pandemic did not have a significant effect on representatives' approach to ethical shopping for any of the generations. Only 18% of Gen X consumers, 19% of Gen Y consumers, and 22% of Gen Z consumers reported some degree of influence, i.e., attitude changes. The rate of direct purchase of ethical products did not increase significantly with the monitored groups in connection with the waste in the Covid 19 pandemic. Thanks to the awareness of a broader context of the relationship between lifestyle and the impact on the environment, this situation had a positive effect on only 17% of consumers of Generation X, 19% of Generation Y and 21% of Generation Z.

Table 3. Testing the significance of differences among generations X, Y and Z in the case of the intensity of direct ethical products purchasing

	Chi-square	SV	p
Pearson chi-square	27.0590	df = 6	p < 0.001
M-V chi-square	27.4121	df = 6	p < 0.001
Contingency coefficient	0.1626		
Cramer's V	0.1165		

As shown in Table 3 above, in the case of the intensity of a direct purchase of ethical products, a statistically significant difference was demonstrated between Generation X, Y and Z. The intensity of a direct purchase of ethical products is statistically significant ($p < 0.001$) and weakly ($C = 0.1626$) influenced by belonging to Generations X, Y and Z.

The reason for Generation X for taking into account ethical values in the purchasing decision-making process is, in order of importance, the desire to help (39%), a sense of personal responsibility (27%), interest in ecology/environment (21%) or a combination of these interests. Compared to Generations Z and Y, this group has the most outstanding effort to help (chart 1). On the contrary, the reason why ethical principles are not reflected in the purchase choice is a lack of information (39%), lack of knowledge of ethical principles (30%), limited options for purchasing in the retail network (20%), and personal lack of interest (11%).

The main motivators for Gen Y consumers when shopping ethically are a sense of personal responsibility (39%), a desire to help (23%) and an interest in ecology/environment (22%). The most important reason why this group of respondents does not make ethical purchases is the lack of information (38%), ignorance of ethical principles (24%) and poor availability in the retail network (22%). A personal lack of interest was mentioned by 16% of respondents.

Among the reasons for people of Generation Z for which the ethical aspects of the purchase are relevant include a sense of personal responsibility (38%), an interest in ecology and the environment (24%) and an effort to help (21%). It is interesting that representatives of Generations Y and Z almost agree with the reasons for considering ethical values when

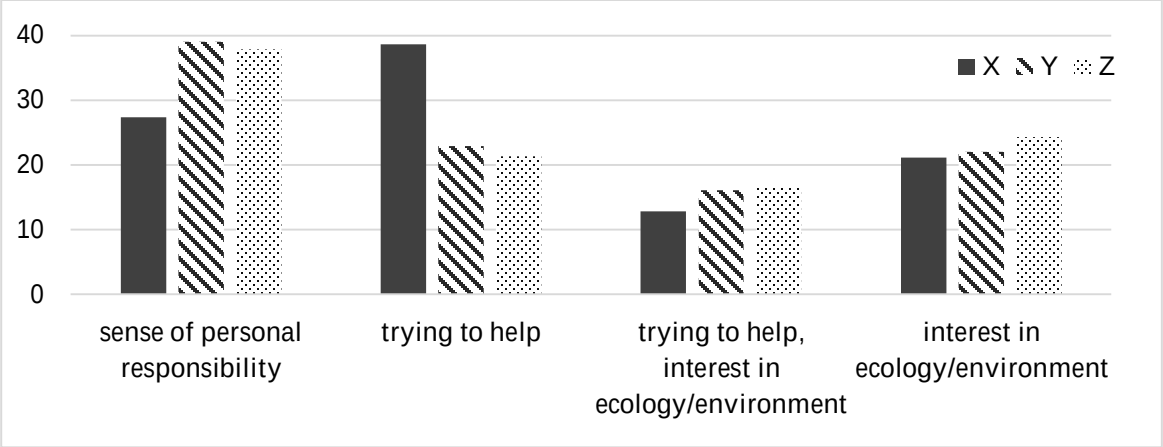

Figure 1. Differences in generations X, Y and Z in reasons for ethical products purchasing (%)

purchasing consumer goods and their importance. For this group, too, on the contrary, the main reason why consumers do not buy in this way is the lack of information (40%), limited availability (26%) and the lack of knowledge of ethical principles (21%). A personal lack of interest was stated by 14% of respondents.

The source of knowledge and information in the context of ethical values for the fifth consumers in the Generation Y (21%) is the press, television and various forms of printed publications. Only 12% of people actively and purposefully search for information at the same time (Figure 2). In this case, the findings are comparable to the characteristics of Generation X. This is a meagre number, which is essentially repeated at a similar level for all monitored groups (12% of Generation X and 14% of Generation Z). Of course, it cannot be expected that the issue of ethical values in shopping will be of equal interest to all shoppers. However, an increase in the number of active consumers can be achieved through proper communication.

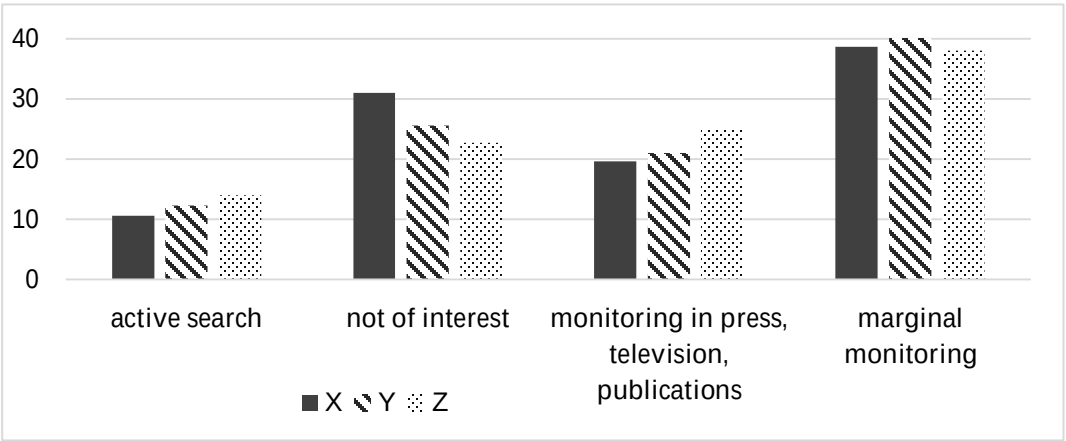

Figure 2. Differences in generations X, Y and Z in information monitoring in connection with ethical purchasing (%)

Generation X does not differ significantly in the ways of acquiring knowledge and information. Only with the fact that in this group of consumers, there is the largest percentage

of people who indicate that information with the character of ethical values is not of interest to them, namely 31% of people (Generation Y 26%, Generation Z 23%).

64% of consumers boycott products or services in the event of spreading information about, for example, violations of human rights, restrictions on the favourable living conditions of animals or major damage to the environment. However, information of this nature is not always available to the general public (as already mentioned, only about 11% of consumers actively search for information themselves). There is also room to improve consumer awareness towards transparent and non-damaging actions of, for example, manufacturing or trading companies and service providers. The most common reasons why consumers are willing to boycott products are ethical and humane aspects and ecological aspects or a combination of the above options across all generations. Therefore, consumers are aware of the importance of the responsible approach of companies and are willing to take it into consideration in their purchasing decisions.

Only a small proportion of Gen Xers are influenced in their decision-making by recommendations originating from YouTube (8%). For the vast majority, this channel is, therefore, not relevant. This generation is more likely to be influenced by other social networks. The influence of shared video recordings with the theme of ethical values and, with it, the influence of specific authors of these recordings on YouTube is not essential in the case of Generation Y. Only 15% of consumers are influenced to some extent by this channel. Therefore, it is possible to say that other forms of communication and other channels are more suitable for sharing and expanding the awareness of Generation Y's representatives about ethical shopping. 28% of representatives of Generation Z are at least partially influenced by YouTube spots. This can be used in marketing communication by targeting specific communication channels.

Table 4. Testing the significance of differences among generations X, Y and Z in the case of the influence of the recommendation for ethical purchasing via YouTube

	Chi-square	SV	p
Pearson chi-square	59.3078	df = 6	p < 0.001
M-V chi-square	59.4253	df = 6	p < 0.001
Contingency coefficient	0.2371		
Cramer's V	0.1726		

As seen from Table 4 above, a statistically significant dependence ($p < 0.001$) of the influence of recommendations for ethical shopping via YouTube on the generation and age of the respondents was demonstrated. Even in this case, the dependence can be characterised as weak ($C = 0.2371$).

4.2. Ways of Communicating Sustainable Consumption

The research found that in a number of characteristics related to the approach of representatives of individual groups, Generation Y and Z consumers are identical or very similar. Differences were noted in the approach of Generation X. These differences and the findings can be used in the communication of ethical values and ways in which representatives of these groups can be addressed. To design marketing communication as

effectively as possible and within the context of the conducted survey's findings, the following aspects can be recommended as an area of focus for Generation X:

- emphasising the aspect of help and personal responsibility,
- support, for example, awareness of ethical principles through various educational campaigns,
- support ethical and humane aspects of communication,
- strengthen the perception of the impact of decision-making on the environment,
- use elements of visual communication, work with brief messages.

It is said that one of the typical features of Generation Y is that they are generally not afraid of the new, as their childhood and adolescence were characterised by various changes. This is also possible to be used in marketing communication and appeal to the globally changing environmental conditions and the necessity of a change in behaviour towards an emphasis on ethical values. Considering the characteristics of Generation Y, a combination of different communication forms via television and the press with a stronger focus on media such as computers, tablets, and mobile phones can be recommended as the most suitable forms of communication. Communication through websites and blogs will also work very well with this generation. In the case of Generation Y, it is possible to recommend focusing on the following aspects in the context of the findings from the conducted research:

- to increase awareness of the possibilities of benefiting from the purchase decision to other persons/organisations,
- emphasise a sense of personal responsibility,
- promote awareness of the forms and principles of eco-friendly shopping,
- to make available information about ethical values related to the purchase of consumer goods in the form of news and reports on television and the press,
- improve consumer/general public awareness of the ways in which consumer goods are produced and sold in terms of unethical behaviour,
- emphasise impacts of purchasing and other behaviour on the environment.

As the survey showed, in the case of group Z, video content on YouTube channels can be an effective communication tool. From the perspective of marketing communication, in the case of Generation Z and within the context of the findings from the conducted survey, it is possible to recommend focusing on the following aspects:

- aspects of the impact of purchasing choices on the environment,
- appeal to a sense of personal responsibility and the support of ecology and the environment,
- promote awareness of forms of eco-friendly shopping,
- promote awareness of the principles of ethical purchasing,
- use social networks and mobile devices in communication,
- improve the availability of "ethical" products in the retail network,
- make brands and symbols that declare the relationship to the environment more visible,
- support the availability of information about unethical and inhumane products.

All three statistical hypotheses (H_{01}, H_{02}, H_{03}) were rejected in favour of alternative hypotheses:

- H_{A1}: Interest in the origin of goods depend on whether the consumer belongs to generation X, Y and Z (RQ1).
- H_{A2}: The frequency of buying ethical products depend on whether the consumer belongs to the X, Y and Z generation (RQ2).
- H_{A3}: The extent to which consumers are influenced by YouTubers when purchasing ethical products depend on the consumer's belonging to generation X, Y and Z(RQ3).

5. Discussion

There are numerous differences between generations in how Generation X, Generation Y and Generation Z perceive the importance of sustainable consumption and how they project the influence of ethical considerations into their purchasing behaviour. Gen Xers are technologically savvy because they grew up with technology evolving throughout their lives. Therefore, Gen Xers are able to use computers, cell phones, laptops and other devices well (Costello, 2020). Gen Xers are shown to be shrewd pragmatists who focus on themselves rather than society (Boyd, 2010). Even so, in the case of Generation X, the research found that the most important reason for considering ethical values in the purchase decision-making process was the desire to help. Generation Y consumers are associated with a preference for environmentally friendly, socially responsible, and technologically advanced products. They are also known to be quick spenders and inclined to hedonistic consumption (López-Fernández, 2020). Generation Y is also very family oriented. Arli et al. (2019) report that Millennials' views on ethics are more relaxed than those of the previous Generation X. In contrast, the study by Curtin et al. (2001) found that ethical codes and expectations of Generation Y are high, which was also confirmed by the research conducted. The change in the perception of acceptable ethical behaviour is even more significant with Generation Z, as the results of a study (Barna, 2018) show. The morale of Generation Z has changed dramatically, and beliefs about moral relativism prevail. Members of Generation Z believe that changes in what is morally right and wrong are strongly influenced by society and depend on personal beliefs (Klopotan et al., 2020).

6. Conclusion

It is evident that in the case of marketing activities, it is not possible to approach all customers in the same way in order to achieve the optimal effect. Supporting the purchase of ecological products and the role of communication for sustainable consumption are two important prerequisites for the further development of ethical shopping. Marketing communication can be a very effective tool that can significantly promote general consumer awareness of ethical shopping principles and encourage consumers to make ethical purchases for their own consumption. Research has shown that Generation Y and Generation Z consumers are the same or very similar in a number of characteristics related to the attitudes of individual groups. Differences were recorded in the approach of Generation X.

These differences and findings can be used to communicate ethical values and ways to approach representatives of these groups. A further continuation of the research could be finding out differences in communication between generations in terms of, for example, the influence of gender or education.

Conflict of interest: none.

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Mortality Forecasting – Which Arima Model to Choose for Vector K_T Projection in Lee-Carter Model?

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Abstract: The aim of the paper is to compare two possible methods of projections of the vector k_t in the model and to forecast the age and sex-specific mortality rates in the Czech Republic for next 20 years based on stochastic modelling method. Particularly, we used Lee-Carter model that is based on Principal Component Analysis and is estimated by Singular Value Decomposition method. It estimates age-dependent parameters a_x and b_x and time-dependent vector k_t. Projection of the model's vector k_t can be done by the best ARIMA model or by average ARIMA model based on the smoothed Akaike information criterions. Both k_t are used for forecasting of the mortality rates for period 2021–2040. Forecasting was done in R package demography. The parameters a_x and b_x had expected development. However, best ARIMA model chosen by package forecast did not project k_t realistically. External calculation in EViews software chose average ARIMA model that created better k_t projections. This is reflected in the results of the forecasts of the mortality rates $m_{x,t}$. It can be concluded that the forecasts of mortality rates based on the k_t parameter projected in software EViews is smoother and more realistic.

Keywords: forecast; Lee-Carter model; mortality rates

JEL Classification: J11; C38; C18

1. Introduction

Mortality is one of the demographic processes that are an integral part of the population projections. Projection of the population state is needed for the decision-making purposes. For example, Fiala, Langhamrová, and Průša (2011) projected the human capital (approximated by the education of the population) of the Czech Republic and its regions to year 2050.

There are two approaches towards the demographic projections. However, "nowadays it is not enough to construct the demographic projections based on the deterministic models." (Šimpach & Langhamrová, 2014). Therefore, stochastic model that accounts for random errors are used despite that they are more computationally intensive than deterministic models.

The first stochastic model elaborated by Lee and Carter (1992) has been used since that on many applications and many extensions that improves its forecasting functions has been added. Its advantage is relatively easy computation based on Singular Value Decomposition method. "Among the forecasting advantages are the minimal subjective judgement required (and the relative accuracy of forecasts compared to those based on methods incorporating greater judgement), and the production of probabilistic prediction intervals." (de Jong et al., 2020)

On the other hand, Lee-Carter model is based on historical mortality data and project them into the future. It extrapolates historical trends and forecasts probability distributions of age-specific death rates using standard time-series procedure. (Li & Lee, 2005). This imply that when there is an exogenous shock, it can be reflected in the forecasts (they can be distorted). Despite that the oldest history has the lowest weight in the prediction model it can quite be important even with a little weight, because mortality is a long-term process that has for each population its long-term trend. (Booth et al., 2005).

Another disadvantage of the Lee-Carter model is that the age-specific set of the b_x parameter is estimated on the basis of historical data and does not develop in time. Parameter b_x indicates which rates decline rapidly and which rates decline slowly in response to changes in k_t (time-varying index of the level of mortality for all ages). However, mortality in countries with low infant mortality (Czech Republic is one of them) declines faster in older ages than in young ages (so-called ageing of mortality decline). The assumption of the Lee-Carter model that the pattern of change in mortality is fixed over time is too strong. The shortcomings of the model were evaluated e.g. by Lee and Miller (2001).

Original model was applied by Lee and Carter (1992) on the U.S. population data from year 1933 to 1987 and forecasted mortality rates up to year 2065. de Jong et al. (2020) enlarged the time series of U.S. mortality rates on years 1933–2017 and extended the model by normalization of the parameters, so they have a direct and intuitive interpretation, comparable across populations. They also introduced "needed-exposure" which is "the number required in order to get one expected death and is closely related to the "needed-to-treat" measure used to communicate risks and benefits of medical treatments" (de Jong et al., 2020).

Disadvantage of b_x parameter was solved by Li et al. (2013) who suggested its rotation that is the phenomenon that in developed countries, mortality decline is decelerating at younger ages and accelerating at old ages. They used mortality rates from Japan and U.S. and forecasted the mortality rates up to year 2098.

Booth et al. (2002) fitted the Lee-Carter model to Australian data for 1907–1999 and found that the "universal pattern" of constant mortality decline as represented by linear k_t did not hold over that fitting period. Therefore, they modified in the later study the method to adjust the time component to reproduce the age distribution of deaths, rather than total deaths, and to determine the optimal fitting period in order to address non-linearity in the time component. (see Booth et al., 2010).

In the Czech Republic, Šimpach and Langhamrová (2014) modelled age-specific mortality rates in the period 1920–2012 by individual random walk with drift and by Lee-Carter model based on Principal Component Analysis method. They concluded that results obtained by Lee-Carter model reflect better the expectation. The random walk models can be used only for the female population. In our article stochastic approach to forecast the mortality rates was used.

The Czech Republic belongs to the developed countries with relatively low mortality rates. As can be seen in Figure 1, the development since the year 1960 was not favourable, as the total (crude) mortality rate had been increasing up to year 1980 when it was the highest

(almost 132 deaths per 1,000 inhabitants). Then, it started to decline and reached its minimum in year 2014 (100 deaths per 1,000 inhabitants). Year 2020 noted sudden increase of the crude mortality rate due to the Covid-19 pandemic. The trend of decreasing mortality (expressed by 5-years moving average) was broken.

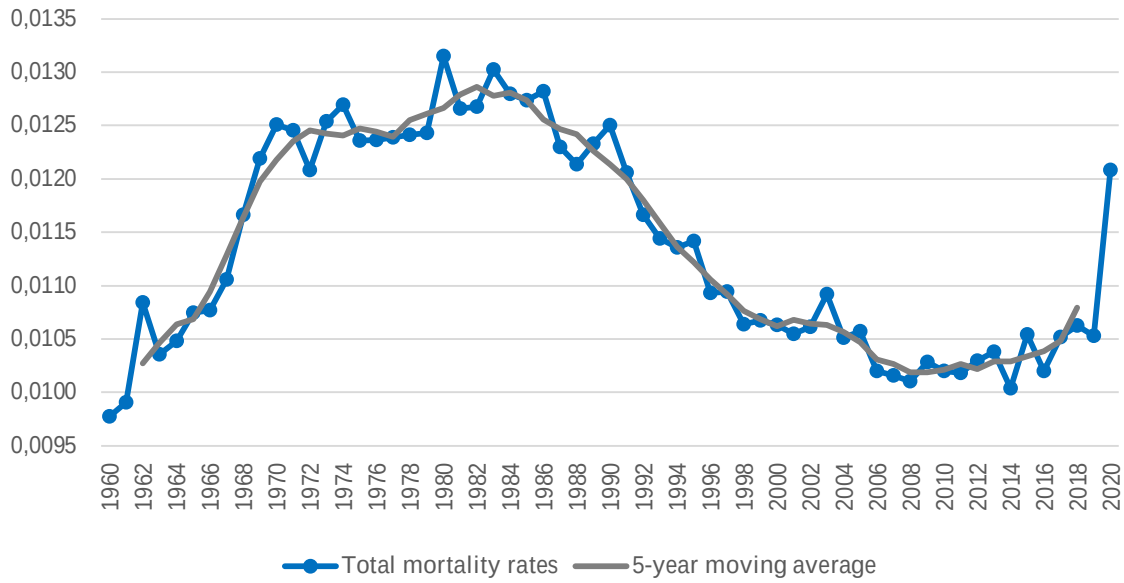

Figure 1. Development of total (crude) mortality rates and trend expressed by 5-year moving average in the Czech Republic in 1960–2020 (Source: Eurostat (2022), own elaboration)

An important factor that must be taken into account when assessing mortality is the age composition of the relevant population. Differences in mortality are also evident between the sexes. Therefore, age and sex-specific mortality rates are taken into account for forecasts. Usually one or five-years age categories are considered and the forecasts are done separately for males, females and total population.

2. Methodology

The data about mortality rates were gathered and calculated and Lee-Carter model was applied on them to forecast the mortality rates in the Czech Republic for years 2021–2040.

2.1. Data

The dataset of mortality rates $m_{x,t}$ is needed for the calculation. Eurostat provides data about mortality rates from year 1960 up to year 2020 in *Life table by age and sex*. However, the last category is only 85 year or over that is not sufficient for the analysis of mortality in the highest ages. Therefore, the death rates (central mortality rate in time *t*, $m_{x,t}$) were calculated as division of number of deaths in time *t*, $D_{x,t}$, and mid-year population state in time *t*, $P_{x,t.}$ Data about *Population state at 1st January* and *Deaths by age and sex and population on 1st January* were taken from Eurostat (2022). By the calculation was gained the dataset with 1-year age categories from less than 1 year up to 99+ for total population, males and females for years 1960–2020. The projection period was chosen to be 20 years: 2021–2040.

2.2. Lee-Carter Model

The future mortality rates were forecasted by Lee-Carter model developed by Lee and Carter (1992). The model is based on Principal Component Analysis and is estimated by Singular Value Decomposition method. There are 3 parameters of the model that have to be estimated: age specific term which represents the general mortality shape across age (a_x), age-specific profiles which rates decline rapidly and which rates decline slowly in response to changes in k_t (b_x) and time-varying index of the level of mortality for all ages (k_t). k_t indexes the intensity of mortality.

The model is defined to fit the matrix of mortality rates in a form of exponential function that can be linearized by the natural logarithm (1).

$$\boldsymbol{m}_{x,t} = e^{\boldsymbol{a}_x + \boldsymbol{b}_x \boldsymbol{k}_t + \boldsymbol{e}_{x,t}} \quad or \quad ln(\boldsymbol{m}_{x,t}) = \boldsymbol{a}_x + \boldsymbol{b}_x \boldsymbol{k}_t + \boldsymbol{e}_{x,t} \tag{1}$$

A vector of column indices of mortality rates m_x is used to estimate the a_x parameter. "As the model written in this way is over parametrized, the two additional constraints are introduced in order to identify the model." (Danesi et al., 2015): $\sum_{x=1}^{N} \mathbf{b}_x = 1$ and $\sum_{t=1}^{T} \mathbf{k}_t = 0$. Using these constrains, the least squares estimator for $\mathbf{a}_x$ can be obtained by (2):

$$\hat{\mathbf{a}}_x = \frac{\sum_{x=1}^{N} \log(\mathbf{m}_{x,t})}{N}. \tag{2}$$

Under this normalization, b_x is the proportion of the change in overall log mortality attributable to age *x*. Both parameters a_x and b_x are time-invariant that is one of their disadvantages.

Vector k_t changes in time, so it is projected to the future. The development of the variable k_t is usually projected by ARIMA (an autoregressive integrated moving average) models elaborated by Box and Jenkins (1970). For example, Lee and Carter (1992) used random walk with drift. Russolillo (2017) used the ARIMA (0,1,0) model to forecast the index of mortality k_t for next 25 years. Šimpach and Dotlačilová (2016) used ARIMA (1,1,0) with drift.

AR (autoregressive) process of the model reflects the development of the dependent variable in time. MA (moving average) process means that the residuum is dependent on its own lags. When only autoregressive and moving average part is present, then we talk about ARMA model that can be used only when the time series is stationary. If the time series is not stationary, its difference of d^{th} order must be done. Than the model is ARIMA (*p*, *d*, *q*), where *p* is the order of AR term, *d* is the number of non-seasonal differences and *q* is the order of MA term (3).

$$Y_t = c + \sum_{i=1}^{p} \phi_i Y_{t-i} + \sum_{j=1}^{q} \theta_j \varepsilon_{t-j} \tag{3}$$

where φ and θ are parameters of the lagged explained variable (Y_{t-i}) and lagged stochastic term (ε_{t-j}), respectively.

Diagnostic of the type of the model is done by Autocorrelation function (ACF) and Partial Autocorrelation function (PACF) that are plotted in order to determine the order *p* of AR process and order *q* of MA process. Correlograms of ACF and PACF are simply the plots of ACF and PACF against the lag length (Wang and Zhao, 2009). The order of lags is determined based on Akaike information criterion.

2.3. Calculation

There are two possibilities, how to project variable k_t to the future. First, the best ARIMA model (according to the Akaike information criterion – AIC) can be used. This can be calculated by package `forecast` in software R that was elaborated by Hyndman (2022) – command `auto.arima`.

Second possibility is to use EViews software with automatic ARIMA forecasting method. This method utilizes an averaging technic based on smooth AIC weights. Algorithm calculates all possible types (combination) of ARIMA models from ARIMA (0,0,0) to ARIMA (4,2,4). Then it selects the best 25 models based on Akaike criterion and calculates the average development of the forecast.

Lee-Carter model itself is estimated and mortality rates are forecasted by Hyndman (2022) package `demography` in R software. Results of forecasted mortality rates by both types of k_t parameters are compared.

3. Results

First, the parameters a_x, b_x and k_t of the Lee-Carter model were calculated. Then the vector k_t was projected using package `forecast` in R and ARIMA in EViews. Finally, the mortality rates are projected for period 2021–2040.

3.1. Lee-Carter Model

Figure 2 shows the development of the estimated parameters of Lee-Carter model calculated in package `demography` (Hyndman, 2022). Parameter a_x for general mortality shape across age shows the fact that the mortality is high in the first year of the people's life and then it decreases sharply. It starts to increase around the age of 10 again with slow down between ages 20 to 30. It only grows since that. The biggest changes of mortality patterns appear at approximately at age 60 years and above due to low numbers of living at the highest ages that leads to small numbers of deaths. (Šimpach et al., 2014). A kink at the end in the highest ages is caused by the fact that there are only few people living at this age and almost all are dying, hence the data are not accurate. The mortality rates can be smoothed by various methods (see e.g. Šimpach et al., 2014).

Parameter b_x is an age-specific profile that tells which rates decline rapidly and which rates decline slowly in response to changes in k_t. It has expected development. It decreases rapidly until the age of 40 and is almost stabilized at certain level until the age of 60. Then it increases up to 80 years and decline afterwards.

However, parameter k_t does not corresponds to the usual development of the time-varying index of the level of mortality for all ages. Its development does not have a decreasing trend but is rather a white noise. In original study of Lee and Carter (1992), k_t declined at a roughly constant rate and had roughly constant variability. It implies that its projection to the future can be difficult.

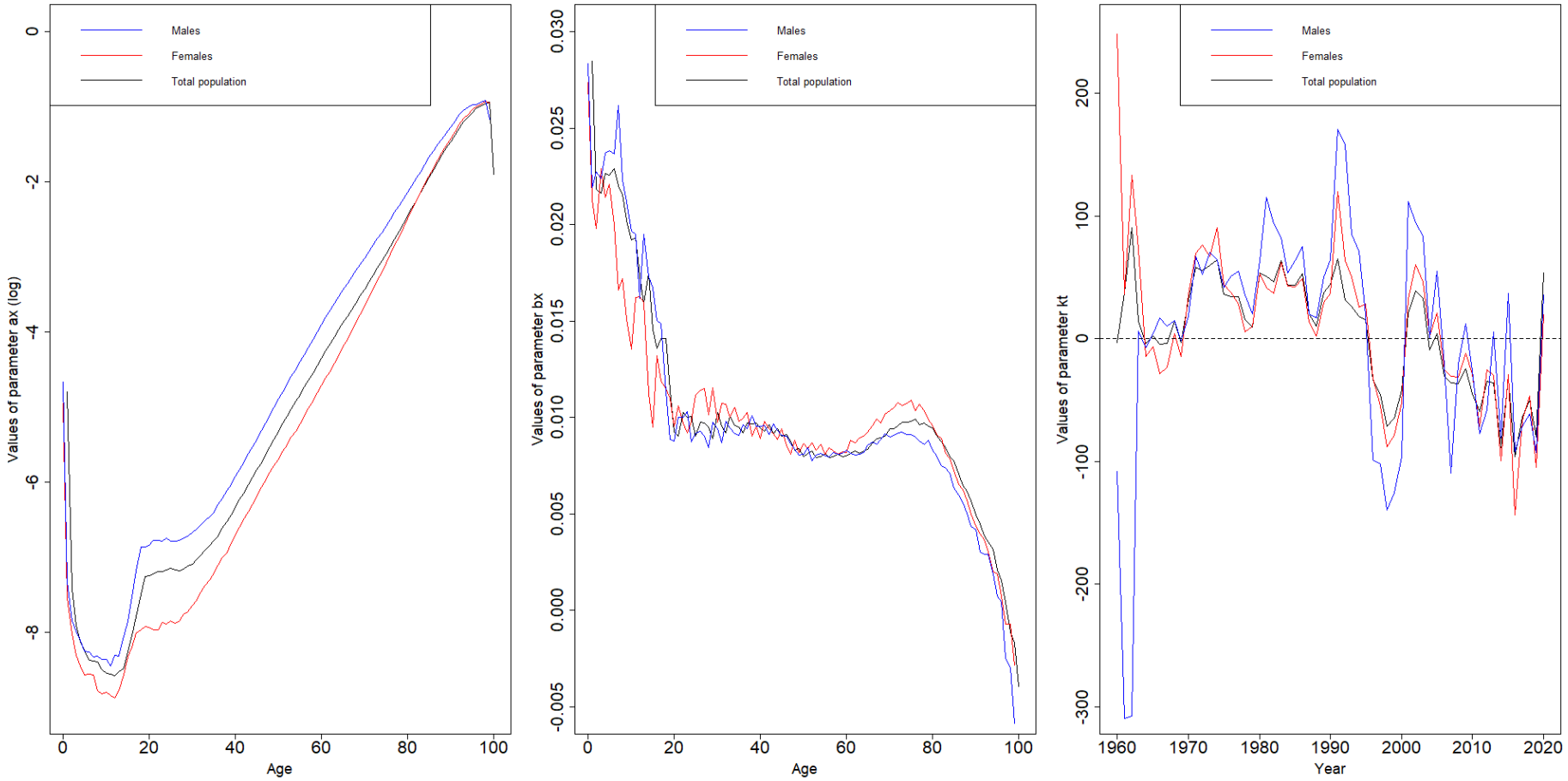

Figure 2. Parameters of Lee-Carter model – ax (left), bx (middle), kt (right) (own elaboration in package demography; (Hyndman, 2022))

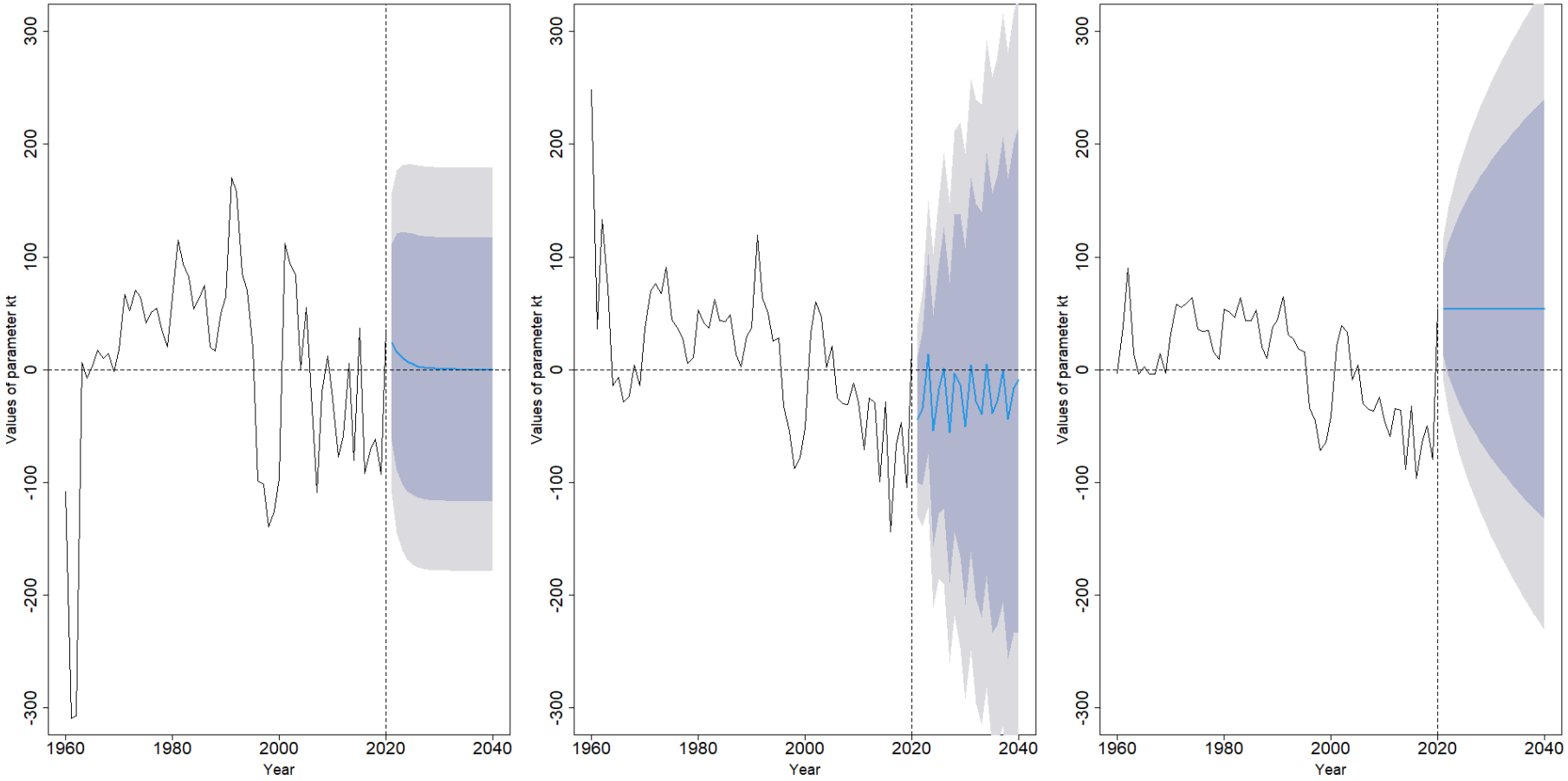

Figure 3. Prediction of vector k_t – males (left), females (middle), total population (right) (own elaboration in package `forecast`; (Hyndman, 2022))

3.2. Projection of Vector k_t

As k_t is only variable that varies across time, its future development is projected. We utilize and compare two approaches. First, a tool called `auto.arima` in R that automatically select one model based on Akaike criterion is used. However, the models seem not to be optimal. As can be seen in Figure 3, the parameter k_t tends to conditional zero mean in case of males, seems to be stationary (or autocorrelated) in case of females and is a constant for total population because there is probably not enough variability (not enough information) in the development of parameter k_t. Usual trend of kt parameter is decreasing – see e.g. Šimpach (2013) where all projections of k_t are straight decreasing line.

Because the results of the projection were not optimal, we tried another tool. The vector of k_t parameters was exported to another software and forecasted by smooth AIC weights. Figure 4 displays possible ARIMA models that were compared with each other. Then the average forecast was chosen by the algorithm incorporated in EViews software. As same as in previous case, the projection of k_t parameter for males tends to 0 value after year 2025. The development is more volatile and below zero in case of females, but less volatile than in previous case. This imply that the forecasting could be easier. Finally, the parameter k_t for total population seems better than previously, because it is not just a straight line. It declines (following the trend of females' population), but slightly consolidates in 2026 and onwards (following the trend of males' population). Those projections correspond to the expected decreasing trend of k_t development (see e.g. Šimpach, 2013).

3.3. Forecast of Mortality Rates

The results of forecasts are displayed in Figure 5. Solid line marks the results of the first approach when k_t was projected in software R (the best model was chosen). Dashed line shows the second approach when k_t is projected in another software and the weighted average ARIMA model is chosen. It can be seen that different projection of k_t parameter gives completely different results.

The forecasts done by original k_t parameter in R package forecast shows high volatility in case of female population which is then reflected in high volatility of total population. This is true for all selected ages. On the other hand, k_t projected by ARIMA models project smoother lines. Surprisingly the mortality of 0-years old is very high for male's population that affect also the forecast for total population. The most stable age groups are around middle age (20 to 60 years), when the intensity of mortality is not fluctuated as a result of either systematic or random influences.

Both forecasts are realistic in following aspects. The mortality is the highest in the infant age and then in the highest ages. Mortality of men is highest than of women in the Czech Republic that is due to the living conditions and lifestyle of men (more demanding work, riskier behavior, addictions etc.). The trend of mortality is decreasing (due to progress in health care, higher living standards etc.). The decrease of mortality rates is faster and the beginning of the forecast period and slows down later. There can be seen the impact of Covid-19 pandemic as and exogenous shock that increased the mortality in 2020. It can be expected

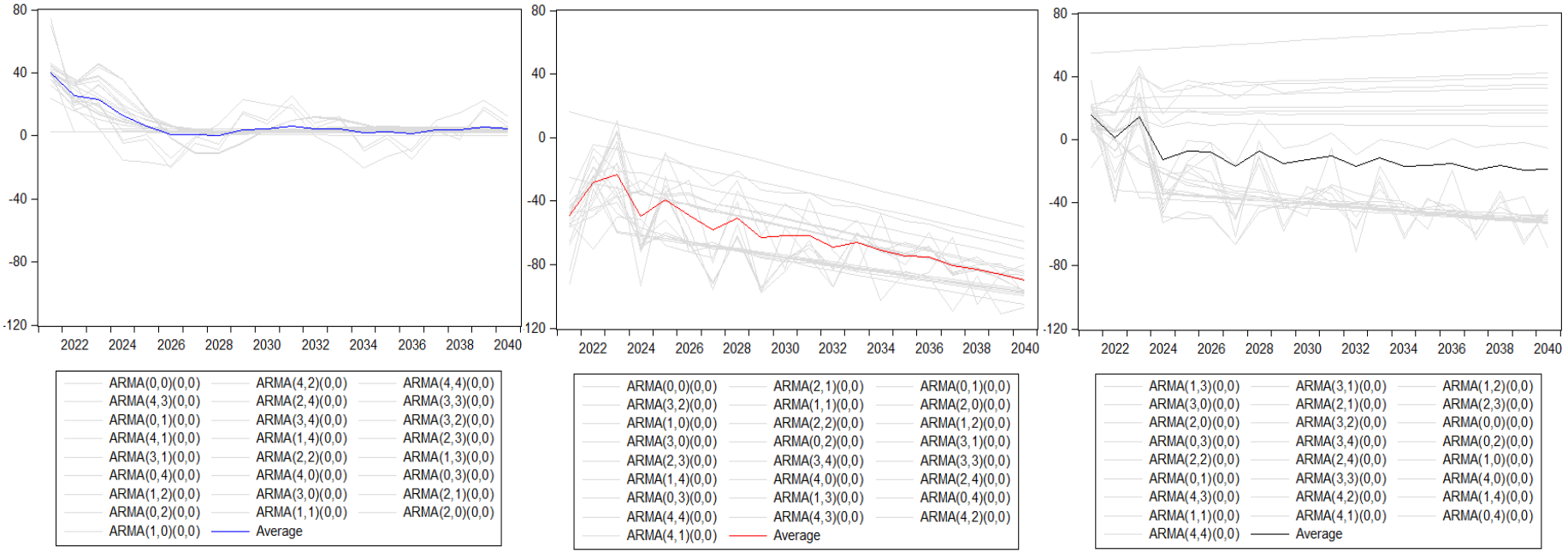

Figure 4. Prediction of vector k_t – forecast comparison graphs – males (left), females (middle), total population (right) (own elaboration in EViews)

Both types of k_t were utilized (and same a_x and b_x parameters) for mortality rates forecast.

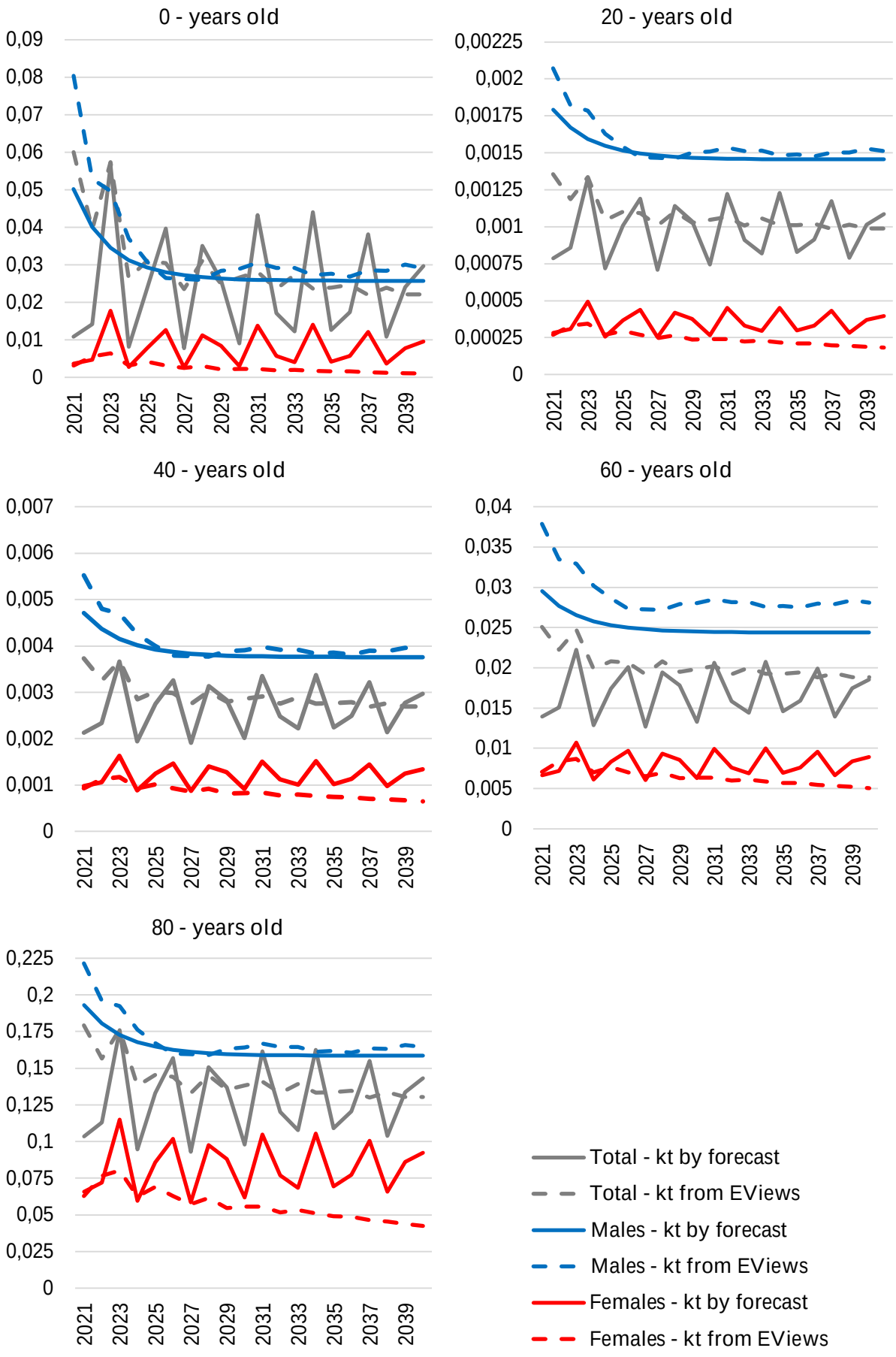

Figure 5. Forecasted mortality rates in selected ages for years 2021–2040 – comparison of two approaches

that also mortality rates in 2021 and 2022 would be affected, but the effect diminishes later. Šimpach and Šimpachová Pechrová (2021) found out that despite the Covid-19 pandemic, the mortality rates will still decrease in their forecast, and that adding data for year 2020 did not change much the decreasing trend that is very strong and rooted in the data since the 1990s when the increase of living standards, after the end of the communist era, caused that the mortality rates started to decrease more.

It can be concluded that the forecasts of mortality rates based on the k_t parameter projected in software EViews is smoother and more realistic.

4. Discussion

Our model expects decline of the mortality rates. However, it shall not be that sharp as before, because the times of speed reduction are already over (From 1980 till approximately 2000 in the Czech Republic). According to Kannisto et al. (1994), developed countries have made progress in reducing death rates even at the highest ages and the pace of this progress has accelerated over the course of the twentieth century. "In most developed countries outside Eastern Europe, average death rates at ages 80–99 have declined at a rate of 1 to 2 percent per year for females and 0.5 to 1.5 percent per year for males since the 1960s." (Kannisto et al., 1994).

We can compare our forecasts with study of Šimpach (2013). He applied Lee-Carter method on Czech population in years 1920–2012 and 1948–2012. He found out that logarithms of age-specific mortality rates in the Czech Republic of men have a visible tendency to decrease faster and with a higher intensity in the future (in particular in the lowest age groups) than is the case for Czech women." (Šimpach, 2013). This would indicate the expected fact that male and female life expectancy could converge. Our forecasts do not show this trend in the near future.

Šimpach (2013) choose to use ARIMA (1,1,0)c model to forecast the mortality rates of males and females and ARIMA(0,1,0)c for total population. We used ARIMA (1,1,1) for males and females and ARIMA (0,1,0)c for total population.

We found out that ARIMA model chosen by `forecast` package in R is not optimal as the projection of k_t and forecast of $ln\ m_{x,t}$ are too volatile. For this reason, we can suggest smoothing of the time series before its inclusion into the Lee-Carter model. In general, the higher the age group, the higher the variability in the data. Especially at very high ages can be observed significant deviations in mortality. The existence of an outlier can cause problems in the forecast. That is why it is important to smooth mortality curve for obtaining better results. Dotlačilová et al. (2014) suggested to use polynomial functions for levelling and for extrapolation of mortality curves at the advanced ages. One of the mostly used method is e.g. Kannisto elaborated by Kannisto et al. (1994) and Thatcher et al. (1998). Kanisto method was suggested e. g. by Šimpach (2013) or Šimpach and Dotlačilová (2012). "A better result would probably be obtained if the time series of age-specific death rates were matched to some of the existing smoothing models, but this could cause the loss of some additional information needed for principal component analysis." Šimpach and Dotlačilová (2012)

concluded that the model based on smoothed data fits better the reality, because it refers to the expected development of the ln $m_{x,t}$ – it declines through the all age groups.

5. Conclusions

The aim of the paper was to compare two possible methods of projections of the vector k_t (indexes of intensity of mortality) in the stochastic Lee-Carter model and to forecast the age and sex-specific mortality rates in the Czech Republic for next 20 years. Lee-Carter model is based on Principal Component Analysis and is estimated by Singular Value Decomposition method. It consists of two age-dependent parameters a_x and b_x and time-dependent vector k_t. Projection of the model's vector k_t was done by two approaches. First, the best ARIMA model was chosen by package `forecast` in software R. Second, average ARIMA model based on the smoothed Akaike information criterions was calculated in EViews software. Both k_t were used for forecasting of the mortality rates for period 2021–2040. Forecasting was done in software R package `demography`.

We found out that parameters a_x and b_x had expected development, so Lee-Carter model works well when it is applied on Czech data. However, the k_t was not calculated according to the expectations. Regarding the projection of index k_t, the best ARIMA model chosen by package `forecast` in R did not project k_t realistically. External calculation in EViews chose average ARIMA model that created better k_t projections which followed expected decreasing trend. This is reflected in the results of the forecasts of the mortality rates $m_{x,t}$. The forecasts of mortality rates $m_{x,t}$ based on the vector k_t projected in software EViews is smoother and more realistic. We suggest external projection of vector k_t or improvement of `forecast` package in software R. Or some changes in the data (smoothing) shall be done to calculate and project realistic vector k_t and hence mortality rates directly in R.

Therefore, the challenge for future research is to forecast the future mortality rates based on the smoothed data of mortality rates in the Czech Republic and to calculate and project more realistic development of vector k_t.

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Conflict of interest: none.

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Decentralized Autonomous Organizations and Trust: Approach to Trust in DAO in the Context of Existing Trust Theory

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Abstract: We are witnessing how numerous trends, including decentralization and the growing role of technology, permeate the way companies are organized, intersecting with the phenomenon of Decentralized Autonomous Organizations (DAO). This technology-based organization carries a pattern known as a zero-trust policy, aiming to eliminate the need for trust in an organization. It appears to oppose the existing research on trust in management and its usefulness to organizations. That brings the question of whether DAOs represent a change from a trend defined by a standard trust theory. This conceptual paper answers by looking at the Decentralized Autonomous Organizations phenomenon through the existing knowledge on trust, specifically through Dirks & Ferrin's trust theory, and compares the concept with the traditional organization. The investigation suggests that DAOs only partially eliminate or transform the need for trust compared to traditional organizations; the need for trust is still present and may even grow in future concept development.

Keywords: DAO; trust; blockchain; confidence; zero-trust policy; decentralized autonomous organizations

JEL Classification: M12; M13; M15

1. Introduction

1.1. Framing the Topic

With the evolution of management, new concepts of organizing entities and the individuals within them naturally come to reflect the demand of current stakeholders, typically leaders and members. One such concept is the contemporary phenomenon of Decentralized Autonomous Organizations (DAOs), which respond to the changed values following the crisis of trust in authority and consequently attempt to protect their participants. The concept follows the ongoing trend of decentralization in management affected by environmental uncertainty, the need for innovation, and a trust crisis, trying to reach a trust-free environment. The specificity of the DAO approach to trust, which seems to be in opposition traditional organization approach, predetermines this paper´s goal - finding if and how DAO shifts our current perception of trust in organizations (Conti, 2015; De Filippi et al., 2020; Gassmann & Zedtwitz, 2003; Hassan & De Filippi, 2021).

Decentralized Autonomous Organizations stand on the edge of two worlds: management and IT. Their origin is in information technology, from which they draw design elements, for

example, zero-trust policy from IT security, that are then transferred and applied in the management field, specifically organizational design (Buck et al., 2021; Liu et al., 2021). This paper analyses the approach to trust that DAOs bring from the technology world, how this approach fits into existing research, and the definition of trust. For this purpose, trust is framed as a "psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (Dirks & Ferrin, 2001). However, DAO itself overwhelmingly does not explicitly define trust within the academic literature (De Filippi et al., 2020).

1.2. Understanding DAO

Decentralized autonomous organizations are companies that have been developing in recent years, whose design aims to increase the degree of democracy and egalitarianism and avoid the need for a central authority in the form of managerial layers. It achieves the goal by using blockchain technology, which provides the organization's members with voting mechanisms applied to all decision-making, and smart-contract technology, which includes and automatically executes internal rules and agreements. Membership in an organization is represented by the token ownership issued by a DAO, which is written in the blockchain and gives the right to participate in the organization's decision-making. (Hassan & De Filippi, 2021)

The purpose and origin of this organization type is the distrust of traditional organizations and their central authorities, such as top management, and the desire to bring an alternative that does not condition the organization's functioning on trust in authority. Examples of specific DAO organizations are Steem or the DAO. Among the reasons to research decentralized organizations is that they represent a critical broader trend of democratization in organizations that is visible, especially in recent years, to an increased degree. It is also a remarkable example of how technology permeates and influences management on a massive scale. (Liu et al., 2021)

1.3. Understanding Trust

Although trust may be considered a virtue in the general public, in reality, it is a pragmatic survival mechanism that is beneficial both in child development and for the individual (Kramer, 2009). In the broadest framework, trust can be understood as the willingness to accept risk, considering that trust often leads to behaviors with increased cooperation (Dirks & Ferrin, 2001).

Organizations and their internal collaboration create complex dependencies between employees, and trust enables these employees to work together more effectively. Moreover, its importance increases with the development of organizational designs that bring greater independence and autonomy to employees and the associated decrease in control mechanisms. (Mayer et al., 1995)

1.4. Stating the Issue

The organizational governance mechanism that is part of the concept of Decentralized Autonomous Organizations has an inherent premise known as zero-trust policy or trust-less

governance. This tells us that when building a system (in our case, an organization), firms assume that each stakeholder is a potential threat to the others, and need for the trust should be avoided (Buck et al., 2021; Rikken et al., 2019). On the other hand, if we look at existing management research on trust, for example, in Kurt T. Dirks and Donald L. Ferrin's (2001) paper, where they summarize the findings of previous researchers, there is a strong consensus that "scholars from various time periods and a diversity of disciplines seem to agree that trust is highly beneficial to the functioning of organizations" (Dirks & Ferrin, 2001). Examples of these scholars are Costa (2003) and McEvily et al. (2003). The literature of the previous forty years leads us to believe that trust in organizations is something positive and desirable.

This paper aims to answer the research question of whether DAOs, unlike traditional organizations, succeeded in avoiding the need for trust in their inner functioning, so they represent a shift from current theories of trust in organizations. The topic has been specified as a gap in the research literature (Beck et al., 2018).

1.5. Stating the Background

Although the concept of Decentralized Autonomous Organizations is relatively young, several dozen academic publications have already addressed its mechanisms, applicability, and limitations (Hassan & De Filippi, 2021; Rikken et al., 2019). These publications look at the phenomenon mainly from a technological and legal perspective, although the organizational design perspective is also partially present (Liu et al., 2021). Paradoxically, the DAO literature often mentions trust or mistrust but rarely defines it (De Filippi et al., 2020).

DAOs are organizations in which leadership, member, and owner roles are not divided among individuals, but everyone participates in all of them. DAO's essential tools for internal operations are blockchain and smart contracts. What is significant is that the idea of blockchain is based on mistrust. It is a database whose specificity is that, unlike the standard ones, it does not lie centrally in one place but is distributed among many participants in the organization to reduce risks. A blockchain does not distribute the information in the individual repositories to complement each other but duplicates information. The purpose of this approach is distrust in one central authority that could modify the data to its advantage and, at the same time, distrust in the individual participants of the system who could potentially change their instance of the database to their advantage as well. If one participant did this within the blockchain, his behavior would be revealed by information inconsistency with other nodes in the system (Hassan & De Filippi, 2021). The emergence of the blockchain as a distributed database and its use within the DAO itself comes from distrusting central authorities and distrusting other participants in a system or organization who are not restricted in any way when joining the organization. A Decentralized Autonomous Organization utilizes blockchain to store essentially two types of information. The first is membership to the organization represented by a token, which also gives a member the right to vote, a.k.a. co-decide the organization's future direction. This mechanism is analogical to shareholders' rights and voting (Hassan & De Filippi, 2021).

A second key element is a smart contract, a piece of programming code that represents and includes rules of conduct of the organization. These rules may only be established or modified

by a DAO member vote. The rules are applied by a smart-contract program itself so that trust in the organization's leadership is not deemed necessary to carry them out as usual in traditional organizations (Rozas et al., 2021).

As described, distrust is present at several levels of the organization's architecture, originating in the ideological basis of its creators (anarchism and libertarianism) and the trust crisis stemming from the 2008 financial crisis. Authorities' failure within this crisis and their relatively centrally controlled organizations have led to disillusionment, a loss of trust in these authorities, and a search for a systemic solution to overcome the need for trust and the risks arising from the agent-principal relationship (Cunningham, 2016; De Filippi et al., 2020; Rozas et al., 2021).

The topic of trust has been gaining a relatively large space in the field of management research, and its issues are addressed in influential publications, including The Role of Trust in Organizational Settings, An Integrative Model of Organizational Trust: Past, Present, and Future or An Integrative Model Of Organizational Trust (Dirks & Ferrin, 2001; Mayer et al., 1995; Schoorman et al., 2007). The most cited benefits of trust are a positive attitude, increased cooperation, and improved performance (Schoorman et al., 2007). By contrast, there is disagreement across publications on the directness with which trust in an organization affects variables like cooperativeness. Other differing positions of view on trust are seeing it as (1) "being about expectations of future behaviour of another party" (Dirks & Ferrin, 2001) and (2) "being about interpretations of behaviour, the motives underlying those behaviours" (Dirks & Ferrin, 2001), but for this article, analysis is operating with the first view that prevails. Authors even consider the presence of trust in an organization as necessary for certain functions, for example, promoting cooperation (Dirks & Ferrin, 2001).

According to the above, the two areas, DAO and trust research, seem to be in apparent contradiction, as if the DAO consciously sacrifices the benefits associated with trust in favor of the need for less risk in the interaction.

The importance of exploring the relationship between Decentralized Autonomous Organizations and trust is essential to making a conscious decision about what the adoption and use of this concept brings and takes away in terms of the trust. It is also about understanding whether we are on the cusp of a new approach to trust in organizations, ideally before taking this step on a broader scale.

2. Methodology

This is a conceptual paper building new knowledge based on analytically determined resources to answer the following research question: Do DAOs inherently avoid the need for the trust of their participants contrary to the existing theory of trust? Although it is not usual to report the methodology section for contextual papers (Jaakkola, 2020; Hillebrand et al., 2015), the approach is described further to increase trustworthiness, as defined by Lincoln and Guba (1985). The findings are not distilled from data in the ordinary sense but include consolidation of evidence from previously created concepts and empirical studies. This paper follows the type of conceptual research defined as theory adaptation (Jaakkola, 2020). Its purpose is to revise the current understanding of a concept, in this case, Decentralized

Autonomous Organizations. An established theory (trust theory) was utilized to explore new aspects of the DAO concept. The specific trust theory was chosen based on the broadest recognition and citation.

Data collection was based on the results of searching "Decentralized autonomous organization" in the title and abstract of both empirical and non-empirical articles in the Web of Science database. Within these, patterns in the trust theory described by Dirks and Ferrin were identified (Schoorman et al., 2007). As a secondary data source, articles focusing on trust in the context of blockchains were analyzed. All analytical activities were based on content analysis using the MAXQDA tool.

3. Results

3.1. Trust Definition Meets Technology

As mentioned above, the majority definition of trust is formulated as a "psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (Dirks & Ferrin, 2001). The definition can be understood that trust cannot be placed in technology because the technology itself has no intentions or beliefs, and thus trust can only be present concerning another person. However, it would be a mistake to avoid the topic of trust in technology to distort the discussion of trust in DAO. Every technology has an author, and believing in technology is to believe in the intentions or behavior of the author (De Filippi et al., 2020). Alternatively, trust in technology is drawn from previous positive experiences using the technology or credibility formed by other people's feedback. In any case, cognitive-based trust is present (De Filippi et al., 2020; McAllister, 1995).

Besides the trustee specification, the last prerequisite for trust analysis in the DAO is the specification of the behavior which can be expected from the trustee. Here it is possible to follow the structure defined by B. Nooteboom (2003), which tells us that trust includes:

1. Trust in the abilities of the trustee,
2. Trust in his intentions,
    a) The belief that he performs as best he can,
    b) The belief that he will not abuse the trust to his advantage.

The design of DAO organizations is primarily motivated by skepticism that the trusted person may abuse his/her position (2b), which manifests in organizations as behaviors involving deception, theft, or lying. The source of the distrust that motivated the creation of the DAO concept is the crisis of trust resulting from the global economic crisis of 2008, where this behavior and failure of authorities led to disillusion (De Filippi et al., 2020; Meijer & Ubacht, 2018).

3.2. Trust Evolution in DAO at Various Organizational Levels

Although Decentralized Autonomous Organizations and their mechanisms are branded as zero-trust, trust-free, or trustless, it would be a mistake to assume that one can do without trust fully to function in this organization, involving cooperation and transactions. The DAO

requires less trust from its members at various levels, as discussed in later chapters, and therefore the adjective less trust-intensive seems more appropriate (Pazaitis et al., 2017).

The need for trust in mediator roles associated with traditional organizations is replaced by blockchain, but the question of what gives us confidence in the blockchain itself remains. We cannot have confidence in an organization and its order if we do not have confidence in its building blocks, the underlying infrastructure. Specifically, we should consider the high rate of successful attacks on blockchains, for example, the attack on the first DAO (called The DAO), which damaged its participants and declined its confidence (Liu et al., 2021). The confidence in the underlying blockchain infrastructure of the company comes from trust in the authors of this technology, the architects, designers, and others who designed and implemented it (De Filippi et al., 2020). As mentioned above, trust here is a belief in their abilities, performance, and especially goodwill (Nooteboom, 2003). That is why among other things, trust is still a part of the very core of Decentralized Autonomous Organizations.

The finding that even in the case of DAOs that proclaim to be trust-free, they cannot function without the presence of trust is confirmation that, to some extent, there is still consistency between this concept and existing research on trust stating that "trust is a necessary condition for cooperation" (Dirks & Ferrin, 2001).

One of the DAO characteristics is that it does not separate members, leaders, and owners, so it is appropriate to examine all three levels for analysis purposes. The attempt to replace trust, which is present in traditional organizations, occurs at several of these levels. The most significant shift in trust between the traditional organization and the DAO is at the leadership level. The cause is the above-referred crisis of trust in authorities that happened fourteen years ago. In a traditional organization, leadership roles represent mediators, according to the agency theory agents, who carry out the will of the shareholders, in the agent theory called principals. The DAO concept proposes eliminating the risks of the agent-principal relationship and the associated required trust by eliminating leadership, the extinction of the relationship, and its replacement by technologies (Liu et al., 2021). The agency problem concerning agency theory, which is resolved by replacing agents with technology, is the most strongly emphasized link between DAO and management science. The agency problem in organizations has its cause in separating ownership from principals who need agents to execute their tasks, which establishes the need for trust and/or control (Liu et al., 2021). Dealing with the riskiness of the principal-agent relationship is nothing new in management and has been the subject of many publications, so the DAO is not unique in this respect (Shleifer & Vishny, 1997).

The distrust in the leadership of the company itself has several components. The first is a distrust in making the right decisions about the direction of the company and the changes that will result. Here, trust in leadership is substituted in the mechanism of voting provided by blockchain and tokens of membership, which allow the majority of DAO members, the token-holders, to make decisions (Hassan & De Filippi, 2021). The voting mechanism permeates the entire organization through organizational processes because this voting system drives all its decisions. However, this presupposes confidence in the wisdom of the crowd principle and trust in the majority replacing the central authority. This is where

sufficient arguments that the mass is less manipulable or independent are missing (Mostagir et al., 2019; Vander Schee, 2009). Again, then, we find that the presence of trust in a DAO (at least according to original DAO concepts) is unavoidable, although it has transformed from trust to leadership to trust to deciding majority.

In the case of DAO votes, a related vessel to decision-making is the sharing of proposals for DAO changes that are the subject of those votes. Creating proposals is the right of every DAO member and part of the mechanism (Rikken et al., 2019). Coming up with proposals is one of the ways of sharing information within the organization, and at the same time, according to trust theory, it is risky behavior that requires trust in other members of the organization (Mayer et al., 1995). Another layer of linkage between the DAO is the presence of trust and trust theory in the organization.

The next component of the distrust in leadership is (not)believing that the agreed rules will be followed because, in the traditional organization, the leadership is not only the rule maker and rule enforcer. In the case of DAO, smart contracts secure rule execution. This need for trust in leadership disappears and is replaced only by confidence in technology (Liu et al., 2021).

At the same time, it should be noted that doubts have been raised as to whether a decentralized architecture paradoxically ensures that power will naturally concentrate on a few individuals who will gradually come to resemble entities similar to central authorities (De Filippi, 2019).

Organizational rules of behavior, including the interaction between its members, are governed by the algorithm implemented in smart contracts, which aims to eliminate the need for trust between colleagues. It successfully does so in smart contract code-covered agendas (Liu et al., 2021). The mechanism protects members only to the extent of the activities described in this algorithm, and questions arise as to how deep smart contracts can go with their potential (Beck et al., 2018). The literature speaks similarly about blockchain's impact on colleagues' trust: “As long as people trust the underlying technological infrastructure, it is possible for them to engage in peer-to-peer transactions. But when it comes to more complex social relationships involving sharing resources and assets, blockchain technology alone does not suffice for people to develop trusted interactions” (Pazaitis et al., 2017). Therefore, additional technology layers are emerging on top of the original blockchain and smart-contract functions to reduce the riskiness of interacting with other organization members and to increase what the literature calls cognition-based trust, i.e., belief in colleague credibility (McAllister, 1995; Pazaitis et al., 2017).

This type of trust in colleagues is not necessarily based on one's own experience with that colleague but also on the experiences of others, which are attached to the colleague's account in the form of a record of historical activity and a rating of his/her other contributions, which together form a digital reputation that naturally influences the level of trust in that person (Pazaitis et al., 2017). Interestingly, unlike the original DAO mechanisms, this newer reputation mechanism does not aim to exercise trust or the need for it but to provide the organization members with the information to make their own decisions about trust or distrust, and it does not make these decisions for them.

Experience with the DAO infrastructure tells us that this system, against expectations, tends towards a "considerably centralized and hierarchical way, with only a few core developers having the power to decide which contributions will be accepted or rejected" (De Filippi et al., 2020; Dirks & Ferrin, 2001). It makes itself no different from traditional organizations, and the need for member trust to run the company persists in maintaining satisfactory efficiency, as suggested by the theory of trust.

One of the specific roles in any organization is infrastructure administrator. The term trust-free associated with blockchain suggests that unlike in organizations where central administrators control the infrastructure, there is no need for trust in the case of this decentralized database. Nevertheless, the truth remains that operating in a Decentralized Autonomous Organization requires trust in the roles of validators and miners to not collude in promoting their own interests and coordinately change the records in their favor. The difference from a traditional organization is only partially reduced risk, but the need for trust directed towards validators and miners is maintained (De Filippi et al., 2020).

Organizational trust theories pay attention to how managers should work with trust in their subordinates to be able to perform control activities. This level of relationship and the associated trust in DAOs disappear with the disappearance of managerial roles, and the control function of managers is replaced by control technologies that do not work with trust (Liu et al., 2021; McAllister, 1995). At the managerial or other levels, the DAO does not address trust as a (managerial) intervention and thus does not reflect its positive effects on process functioning and performance reported in the literature (Dirks & Ferrin, 2001). According to trust theory, the idea of the complete elimination of agents in the form of managers and the significant associated reduction in the presence of trust in the organization would potentially lead to a relatively lower performance of that company (Mayer et al., 1995). In some cases, attempts to extend the original DAO design occur and, in some form, include a subset of managers (and thereby implicitly accept a greater presence or even need for trust) to ensure greater organizational functionality. It suggests that the experience with DAOs is consistent with the theory of trust in the organization (Beck et al., 2018; Chen & Cho, 2021). Thus, in the standard form of Decentralized Autonomous Organizations, trust at the management level disappears, but perhaps only temporarily.

3.3. Trust Beyond DAOs Boundaries

Applying the premise of distrusting the participants in the design of an organization and shifting the need for trust in the organization's participants to confiding the technology may lead to the desired effect only in the areas directly covered by DAO rules because, in areas not covered by the algorithm, the protection of the technology is lost. DAO participants depend on blockchain and smart contracts' protection and risk mitigation. However, rules included in smart contracts are gradually evolving with the organization’s development. They can never cover all possible interactions between members, and therefore its participants may find themselves beyond the edge of those rules, exposed by their dependence on DAOs that do not protect them there from the risks at that moment (Hassan & De Filippi, 2021). The mechanism causes that in all situations governed by smart contracts,

when a member interacts with other DAO actors, s/he puts her/himself in greater insecurity. It is because s/he has had a more limited chance to practice trust with them and build up an experience that would indicate their pattern of behavior and the degree of riskiness of trusting them. In other words, the DAO gives less opportunity to build cognition-based trust. At the same time, it cannot entirely remove members of the organization from situations when they interact with others outside the reach of the algorithm and reinforce the need to trust. This combination may ultimately put members at greater risk, directly opposing the DAO's purpose (McAllister, 1995).

As with using technology to store information, such as mobile phones, when we externalize the memory function, we may face new pitfalls in DAOs when the technology we depend on is not available. Then, the relevance and appropriateness of DAOs, when we externalize trust, may also be analogous, and leaning on the weighting of the benefits in areas covered by DAOs against new pitfalls in places not covered by DAOs. The goal of developing Decentralized Autonomous Organizations will be to reach a state where its blockchain and smart contracts are so advanced that they cover most situations and member interactions so that the remaining ones where members will be debilitated are minor and marginal (Wilmer et al., 2017).

The above findings can be condensed into the following coherent answer to the research question. Although DAO concepts attempt to eliminate the need for trust, especially in the early forms, they are only successful to a minimal extent. On the contrary, we find the need for the presence of trust of its participants at many levels of the DAO. Moreover, further development of this concept will lead to a greater need for the use of trust in the organization if it is directed toward commercial exploitation. Thus, decentralized organizations do not represent a phenomenon that denies the conclusions of trust theory.

4. Discussion

Recent research suggests a growing fad for patterns that make DAO organizations operate more effectively and, with it, a concurrent need for trust. These findings emerge, for example, from observations of The MakerDAO, Compound, and others (Sun, 2021; Fritsch et al., 2022). The patterns include, for example, representative proxy decision-making, coalition building, and differing levels of vote power (Zhao et al., 2022; Sun et al., 2022). Thus, we increasingly see the need for trust in actual cases. Gradually, the transferability of traditional mechanisms does not only apply to trust but also, for example, to corporate governance, and others are becoming apparent (Sun et al., 2022).

From the existing signs, using DAOs may be unsuitable for business entities in a competitive environment where you accept trust risks as part of efficiency. To overcome these limitations, we can expect that further development of DAOs will go towards traditional organizations. A suitable hybrid model that adopts some conventional elements, for example, delegation, will be sought.

Implications of the paper are directed both to DAO participants and creators. First, participants should be aware that the concept of Decentralized Autonomous Organizations still inherently requires trust and participation includes risks. Second, even though there is

an apparent attempt by DAO creators and supporters to make a stand against traditional organizations, DAOs share with them more similarities than it may seem, and their further development is bringing these worlds closer. For further DAO progress, it is beneficial to study traditional organizations' practices and occasionally get inspired (Saito & Rose, 2023). It may be necessary, especially when an organization wants to be more efficient and participate in a competitive environment (Zhao et al., 2022).

Even though numbers are not a standard condition of a conceptual paper, the absence of a quantitative dimension represents a limitation to the generalizability, and the ambition is reduced to extending the theory of the DAO phenomenon (Gilson & Goldberg, 2015; Sutton & Staw, 1995).

The assumption of unnecessary trust in the DAO may present risks and potential for abuse, the exploration of which is potentially not only academically but also socially beneficial. It is, therefore, recommended.

5. Conclusions

Although the concept of Autonomous Decentralized Organizations is repeatedly referred to as an organizational governance mechanism that does not require the presence of trust, this is certainly not the case, and DAOs at various levels require the presence of trust. DAOs build on management theories, including agency theory, which is aware of the riskiness of interpersonal relationships and the appropriateness of implementing control mechanisms. DAOs take this view further and seek to eliminate risk without necessary trust (Schoorman et al., 2007). However, existing versions of the DAO have failed in this aim to date and achieved only a partial reduction of the need for trust (Rikken et al., 2019).

The analysis of the relationship between DAO and trust is of great importance because it allows us to consciously decide whether to follow the DAO model for a particular company and thus deprive ourselves of many of the benefits of trust and consider the meaningfulness of this option. Although trust freedom is presented as a virtue of this organizational design, it comes with a cost that arises from trust theory.

It is essential to put new management trends and approaches into the context of existing theories to realize whether we are reinventing the wheel unnecessarily and what consequences the implementation of these trends may have. Looking back at existing theories, we can predict the further development of the DAO concept. It can be assumed that the concept will increasingly consider the outcomes of trust theory so that firms using this concept can be (more) competitive and can enter standard market environments where they have not been so much present so far. Moreover, we already see signs of this direction (Beck et al., 2018). Therefore, even after the advent of the DAO concept, we cannot say that there are organizations worldwide that can fully do without trust in another person.

Conflict of interest: none.

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Current Trends in Project Management

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Abstract: Project complexity keeps increasing and under the global economy circumstances the conditions for project implementation are more and more complicated. This change forces organizations to adapt to the new conditions by improving their internal processes, including consistent application of the new trends of project management. The use of modern trends in project management shows a growing trend in many organizations. Success in the globalized environment and maintenance of a sustainable competitive edge is only possible when the company utilizes agile approaches in project management, and risk management methods according to ISO 31000 assisted by modern software tools. The necessity of knowledge of new trends in project management is the first step to their successful implementation. The purpose of the paper is to introduce some of the current trends in project management. These include the utilization of agile project management methods, project risk management according to ISO 31000, and gaining knowledge of the software products used in the Czech Republic in the context of the IPMA (International Project Management Association) point of view.

Keywords: project management; agile; risk management; software; IPMA; certification

JEL Classification: D81; M11; M15

1. Introduction

Agile project management is based on the Agile Manifesto. The originators were IT developers, or software project authors, who considered current development ineffective. Agile methods soon began to expand to other areas. The effort to improve project development brought about many changes. In the beginning, the customer does not know what they will need for the project, or their requirements change over time. That is why changes should not be suppressed but rather flexibly responded to with quick solutions. (Šochová & Kunce, 2014)

A project is usually commenced by the sponsor´s definition of the objective, the budget, and the schedule (deadline). In the case of agile management rather the opposite is true. Agile project management often begins with a rough idea and the requirements are amended with changes over time. For that reason, the scope of costs and time must be defined beforehand. (Doležal et al., 2016)

Today's global world with increasing competition not only among the traditionally advanced countries but also originating from developing countries makes not only the business but also the public sphere motivated to innovate and improvement of products and services. Competition causes quick marketing of new products, and the supply of complex solutions meeting customer needs, with the risk of high penalties for delays and target parameter nonconformities. The ever-more and more quickly changing environment requires

flexible reactions, identification of potential risks and insecurities and their active control. (Korecký & Trkovský, 2011). The risk management system, its principles, and guidelines are generally described in the ČSN ISO:31000 standard of 2010. The standard describes the systematic process of risk identification, analysis, and effectively addressing and can be applied in any organization, area, or on any level (Korecký & Trkovský, 2011). The standard was revised and updated in 2018 and currently is still only available in its English language version. This second edition repeals and replaces the first edition ISO 31000:2010 by its technical revision. The revised 31000:2018 standard has been used by international experts in risk management. The vital assumptions of successful business enterprising, like activities of governmental authorities and self-governing bodies, include risk control. Integration of risk management in corporate governance is seen as an inevitable part of organizations´ competitiveness.

Project management uses general mathematical and statistical instruments and graphic methods and techniques whose survey and ways of use in project management are defined in the individual chapters focusing on planning and control pursuant to the project plan (Svozilová, 2016). It needs to be realized that such software will always be a mere instrument, support for the implemented system, but never a miraculous solution removing all problems. (Doležal, Máchal, & Lacko, 2012)

The main goal of the paper is to introduce some of the current trends in project management and discuss their role in current project management approaches in the context of the IPMA (International Project Management Association) point of view.

2. Methodology

The paper is based on the analysis of keywords in the context of current project management trends.

In the first step, keywords relevant to the issue of Project Management were determined in the context of experience with project management courses at universities in the Czech Republic and abroad in accordance with the study of materials from the organizations dealing with project management IPMA and PMI (Project Management Institute). The analyzed keywords were:

- Project management;
- Agile;
- Risk management;
- Software;
- IPMA;
- Certification.

In the second step, records of selected keywords in the Google Scholar, Scopus, and Web of Science (Core Collection) databases were analyzed. Occurrence within Open Access approaches was also considered.

The third step was to summarize the results of the keyword analysis in clear tables.

The fourth step is a discussion based on the views of selected authors in the context of current project management trends.

In the conclusion of the paper, the author comments on current trends from the IPMA point of view.

3. Results

The main results of the paper are based on keyword analyses. The Google Scholar database served as a baseline for creating the keyword analysis.

Table 1. Number of records in the Google Scholar database

Keywords	Records in database
Project management	8,420,000
Software	7,290,000
Risk management	5,700,000
Certification	2,840,000
Agile	1,150,000
IPMA	41,900

Table 2. Number of records in Scopus and Web of Science databases

Keywords	All / Open Access	Records in Scopus database	Records in WoS database
Software	All	1,730,273	918,129
	All Open Access	411	265
	Gold	162	140
	Gold-Hybrid	32	24
Risk management	All	731,928	583,848
	All Open Access	233	239
	Gold	92	116
	Gold-Hybrid	23	26
Project management	All	368,283	175,688
	All Open Access	72	52
	Gold	28	27
	Gold-Hybrid	7	6
Certification	All	9,958	53,366
	All Open Access	20	14,390
	Gold	6	5,960
	Gold-Hybrid	2	1,644
Agile	All	39,907	24,495
	All Open Access	8,608	6,334
	Gold	3	2
	Gold- Hybrid	975	888
IPMA	All	1,672	1,595
	All Open Access	323	430
	Gold	107	136
	Gold-Hybrid	15	16

The keyword Project Management (n = 8,420,000) dominates within the Google Scholar database. Subsequently, the keywords Software (n = 7,290,000), Risk management (n = 5,700,000) and Agile (n = 1,150,000) appear. As expected, the keyword IPMA had the lowest occurrence (n = 41,900). On the other hand, the appearance of the word Agile was somewhat unexpected.

Subsequently, keywords in the Scopus and Web of Science databases were analyzed. For these databases, the type of access was also considered (all papers vs. Open Access). Open Access was also divided into subcategories (All Open Access, Gold, and Gold-Hybrid).

The results show that the number of records of the analyzed keywords in professional databases was not as frequent as in the Google Scholar database. When comparing the number of records in the Scopus database and the Web of Science database, we can say that the number of records in the Scopus database is higher than the number of records in the Web of Science database. The only exception was the occurrence of the keyword IPMA within Open Access approaches. Here, the number of records in the Web of Science database was slightly higher than in the Scopus database.

4. Discussion

4.1. Agile Project Management

Šochová and Kunce (2014) state that agile management is dynamic, quick, interactive, adaptive, iterative, entertaining, playful, quickly responding to changes, etc. It is another way of project management, with preferences for other values, such as real outcomes to strict processes, and change to pre-planned progress. To be agile means to follow the agile philosophy. This brings about a different corporate culture and structure.

4.2. Agile Approaches

To prepare a high-standard project plan there are two basic required factors, high-standard processing and knowledge of technology. If these two basic conditions are not fulfilled then planning makes no sense and the project cannot be used. In such case agile project management enters the stage.

The agile approach requires change both on the customer side and on the supplier side, but unless the whole process is supervised by an experienced team with sufficient knowledge and experience it often fails. This approach is correct in cases when an accurate specification of the required project is available. With sufficient technical knowledge and historic experience in similar projects use of agile approaches can be assumed to be correct. At the same time, project changes must be expected, of course not so substantial to change the project scope.

There are also cases in which the following phenomena occur:

- The project is innovative and there are no established and tried planning processes.
- The client is only able to provide a rough project specification, not sufficient for financial and temporal estimates.

- A large number of changes in the course of the project implementation can be expected, with an effect on the whole project's progress and scope (most often after implementation of the previous two steps)

Agile approaches are mainly applied when the customer comes with new requirements for project function improvement all the time. These processes were first developed in the IT field for the improvement and development of new applications. (Doležal et al., 2016)

The decisive aspects are represented by the principles applied in connection with these approaches:

- Incremental supplies

The project is divided into parts that are implemented one by one, in stages. The project team devotes themselves to one part of the project and only when it is completed they move on to the next part. This minimizes the volume of work in progress and permits following the increase of the completed project parts.

- Iterative approach

Project work is again divided into stages characterized by the same length. Project products must be divided into increments permitting their deliveries within the same deadlines, within a fixed "time box" (Doležal et al., 2016).

- Multi-functional teams

Due to limited time and observance of delivery deadlines of the individual project parts close cooperation among individual team members with different expertise and specializations, is needed.

- Customer involvement

If any changes in the project are expected it is necessary to periodically inform the customer and consult the changes with them to gain feedback from the customer. Under agile process management, a customer introducing the specification and after a couple of months of passivity taking over the finished project is an inappropriate model.

- Periodic revision of requirements

In the case of agile projects, the initial specification is often incomplete and inaccurate, which is why consultation of the requirements between the customer and the project team is important to timely grasp all potential changes and new requirements.

- "Agile conduct"

This mainly addresses the structure of the agile team, the necessity of intra-team cooperation, and task delegation. (Doležal et al., 2016)

4.3. SCRUM

The methodology called Scrum development process (hereinafter just "Scrum") is one of the most commonly used agile methodologies. According to Šochová and Kunce (2014) is

Scrum defined as a "Process building on teamwork, customer involvement, regular feedback in short sprints. Scrum is currently one of the most commonly used agile methodologies. "

The methodology is built on self-organizing teams. In Scrum work is specified in backlogs. There are two types of backlogs:

- Sprint Backlog = work the team agreed to complete within the current iteration (sprint). These tasks only represent internal practices of the development team.
- Product Backlog = a list of high-priority items the Product Owner wants to have, developed and sorted by priority, with a defined work tempo.

Scrum defines three key roles of the development team, using various new names for the existing functions. According to Cobb (2015), scrum works best for teams with up to 9 developers. Each team member has his/her predefined role. There are three main roles in scrum:

- Scrum Master (Manager),
- Product Owner,
- Scrum Team (the development team).

Scrum Master is not the team leader in the traditional sense for his powers do not include control over the team. Scrum master is responsible for the correct use of the scrum methodology in agile software development. Scrum master is the intermediary between the team and the owner. He or she organizes meetings and assures that the team members complete the defined processes within the defined deadlines. A different opinion is held by Šochová and Kunce (2014): "*The team coach and moderator. Removing obstacles and taking care of the team development and functioning. Keeping the scrum running. Scrum master is not the team manager.* "this the scrum master helps maximize the value created by the scrum team.

Product owner is the customer representative responsible for the project run and management of its progress. The product owner is the link between the scrum team and the customer. Product owner is selected by the scrum master, the customer and the management. According to Šochová and Kunce (2014) "The owner of the product vision. Product owner defines that needs to be done in the product or the area. Product owner specifies task priority on the basis of contact and discussions with the customer. "One of the most important subjects responsible for product value maximization and work of the whole team. Product owner holds a clear product vision, takes key decisions and is responsible for product vision creation.

The Scrum team or the development team is the project drive. The team consists of multiple individuals with individual tasks. The team consists of experts able to manage design, implementation, and testing. Multi-functionality of team members and repeating work is used for goal achievement.

4.4. Risk

The definition of risk has its history. A brief summary of its historic development can be found in Tichý (2006), who sees the roots of the word in Arabic, Latin and Greek. The Arabic word risq meant a random positive result, the Latin riscum referred to the dangers of water

transport represented by coral cliffs. The Greek derivate of the Arabic risq was connected with both negative and positive events or outcomes. Later history of the risk concept in 17th to 20th centuries ranged around its connection with negative results only. According to the present definitions risk generally means danger of occurrence of damage, loss or destruction or failed business. There is no single established definition of the risk concept. Economic and technical literature defines risk as a probable loss suffered by the risk bearer, expressed in monetary or other units. (Tichý, 2006). One of the many problems of the current risk science is the fact that we are unable to classify or categorize the danger of risk occurrence in any universal system. We are able to do that within a branch or within an organization only. (Hnilica, 2009).

Risk is often seen as danger of a loss occurrence. (Smejkal & Rais, 2013) point out that the theory of finance usually defines risk as volatility of a financial quantity (profit, portfolio value etc.) around an expected value as a consequence of multiple parameter changes. There is no single generally accepted definition of risk.

Project risk is any event that may occur and affect the project with a certain probability and a certain impact. Talking about risk one usually means negative impact on the project in question. But there are also risks with positive impact. These are called not risks but opportunities, though. (Smejkal & Rais, 2013) The other approach sees risk in its positive context. Risk can mean a threat or an opportunity, i.e. if the event defining the risk occurs the project objectives may be threatened or the event may positively affect the project objectives. Project management tends to work with both sides of risk and analyses both threats ad opportunities (PMI, 2017).

4.5. Project Risk Management According to ISO 31000

Risk and opportunity management is a continuous process present across all stages of project life from the initial idea to the project completion. (Doležal, Máchal, & Lacko, 2012). For a project, risk means "uncertainty which may negatively or positively affect fulfillment of the project objectives". (Schwalbe, 2011)

The purpose of risk management is risk mapping, description of their causes and impacts according to the cause – risk – effect model (Korecký & Trkovský, 2011). Risk management is a substantial part of effective project management for every project is exposed to risk. Duly managed projects are the successful ones. (Hillson, 2009) Risk management process includes risk prevention by decisions about measures for their minimization – preventive measures serve for risk prevention, including insurance and reserve formation.

The risk management process consists of four main stages:

- Risk identification,
- Risk quantification – including quantitative as well as qualitative analysis,
- Risk response development,
- Risk monitoring and response control.

These steps include the first step of risk recognition, followed by risk analysis and assessment, preparation of the response plan, risk monitoring and operative control throughout the project implementation period. A more accurate description in included in

ISO 31000 standard, where this process is extended with context specification, risk analysis, assessment, communication and consultation throughout the process. Risk may occur by deviation from the expected results and always affects achievement of the defined objectives. ČSN ISO 31000 standard simply describes risk as the "effect or uncertainty on objective achievement "(ČSN ISO 31000). Even though project management has been used in practice for decades, project risks have only been systematically addressed since 1980s, first just in the form of quantitative risk analysis. (Merna & Al-Thani, 2007)

4.6. Software Support for Project Management

New technologies perform a significant role in many areas of human activity today. Computer hardware, software and networks or utilization of interdisciplinary and global teams have radically changed the work environment (Schwalbe, 2011).

The software tools will be classified by function pursuant to Czibor (2009) as lower-medium- and higher-class instruments.

- Lower-class instruments

These tools only perform the basic project management functions and their price is usually CZK 4,000 per user or even less. They are recommended for small projects and individual users. Representatives of this class include for example Microsoft Excel or Microsoft Access.

- Medium-class instruments

These instruments over the lower-class tool can manage larger projects and simultaneous work of multiple users on multiple projects. All these instruments can create Gantt diagrams and network diagrams and help with critical path analysis, resource allocations, monitoring progress of project works, issue of status reports etc. The prices range between CZK 4,000 and 10,000 per user. The most commonly used software tools of this class include Microsoft Project, Artemis, PlanView, Primavera or Welcom.

- Higher-class instruments

The top category of software tools for project management is represented by premium products, sometimes called software for corporate project management. Licenses for these products are usually sold according to the number of users, the products are integrated in database software on the corporate level and are also accessible over Internet. An example may be VPMi Enterprise Online. (Czibor, 2009):

4.7. International Project Management Association Point of View

It needs to be realized that such software will always be a mere instrument, support for the implemented system, but never a miraculous solution removing all problems. (Doležal, Máchal, & Lacko, 2012). The International Project Management Association (IPMA) focuses on the candidate personality. In the Czech Republic the most widespread certificates include IPMA and PMI. IPMA distinguished between four certification levels identified as A to D. Each level represents an increasing level of knowledge and experience of project manager,

which conditions the certificate obtaining. Levels A-C require passing a written knowledge test on the given experience level, an oral interview and a defined minimum required practical experience in the field. For D level passing the corresponding written test is sufficient. (IPMA, 2015).

In 2015 the competence distribution, known as "competence eye" was amended and extended in the context of issue of the new standard ICB v4 (IPMA, 2015). The amendment concerned project, program and portfolio management and the aim was to reflect project management requirements for individual competences corresponding to the project, portfolio or program context. A new main area classification: Perspective, People and Practice, was introduced. Prospective competences relate to the general model of the needed competences, through which the individual responds to the environment. Human competences are to reflect the areas of personal and social themes. Practical competences combine skills, instruments and specific methods. (IPMA, 2015). This means classification into three main areas (Perspective, People and Practice).

5. Conclusion

Use of new methods in project management shows a growing trend in many organizations. With the help of the knowledge of project management methods and instruments included in the standards and methodologies (of project management) it is possible to succeed in the globalized environment and keep a sustainable competitive edge. The necessity of trend study in project management is the first step to successful implementation of these principles in corporate governance. Use of modern tools and methods of project management facilitated by suitable software instruments brings many benefits to the organization as well as the individual stakeholders. The probability of fulfillment of project objectives is also increased (Svozilová, 2016), resources are used effectively and needs of individual stakeholders are met more readily (IPMA, 2015).

All standards and methodologies (PMBoK, PRINCE 2 and ICB) provide for and promote the possibility of project manager certification. The certification applies to individuals and particular persons or organization-related functions, such as ISO 9000. There is also certification offering application to both individuals and organizations, PRINCE 2. Certificates of PRINCE 2 and the Project Management Institute (PMI) are issued on the basis of passed tests where the applicant proves knowledge of the relevant standard.

Even though the methods of competence development may differ methodology by methodology, what can be generally recommended is to follow modern trends in project management and continuously develop competences of project managers, whether by way of certification or self-education.

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Public Opinion towards Sharing Economy Business Model

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Abstract: The importance of the sharing economy has been growing in recent years and it is now becoming an important segment of the global economy. Positive developments in this field are dependent on understanding the attitudes of the stakeholders in this business model. The aim of the article is to identify public attitudes towards selected general aspects of the sharing economy model using the Czech Republic as an example. Primary data were obtained via a questionnaire survey (N = 614) and processed using descriptive statistics tools. The study shows a relatively low level of familiarity among respondents with the concept of the sharing economy and the business model itself. However, the respondents do believe that the sharing economy model will replace traditional business models in the future. In the opinion of the respondents, neither a lack of ability and willingness to use information technology nor a lack of information hinder development of the sharing phenomenon. Respondents also do not believe that sharing is the preserve of young people.

Keywords: business model; sharing economy; collaborative consumption; public

JEL Classification: D16; Q01

1. Introduction

Sharing, by means of which individuals or groups use, occupy, or enjoy something with others, is a long-established social practice (Schor & Fitzmaurice, 2015). However, it is now expanding widely (Narasimhan et al., 2018) and defining an innovative model of the sharing economy using various kinds of new technologies (Acquier et al., 2017). This unprecedented growth can be attributed to significant technological advances (Cheng, 2016), changing user views on ownership of certain products or use of different services (Botsman & Rogers, 2010), promotion of a collaborative and sustainable society (Heinrichs, 2013; Tetrevova et al., 2019), demand for socially responsible behavior by economic entities (Jelinkova et al., 2021; Tetrevova et al., 2022), and the need for social connectivity among users (Schor & Attwood-Charles, 2017).

The professional literature offers a wide range of definitions of the sharing economy model, this above all being due to the dynamic development of this phenomenon as well as the multitude of constantly evolving business models (Hawlitschek et al., 2018). One example of this is the definition given by Lessig (2008), who first defined the term “sharing economy”. According to him, this concerns “collaborative consumption made by the activities of sharing,

exchanging, and rental of resources without owning the goods" (Lessig, 2008). An alternative view is offered by Botsman (2013), who states that it is "an economic model based on sharing underutilized assets from spaces to skills to stuff for monetary or non-monetary benefits".

Although the sharing economy model has now become mainstream, it is still not entirely clear exactly what this concept represents. After all, as Acquier et al. (2017), Schor and Fitzmaurice (2015) or Tetrevova et al. (2021) state, it encompasses a diverse range of practices and sectors, as well as different types of organizational forms ranging from for-profit to various non-profit initiatives. Examples include carsharing and ridesharing (Heinrichs, 2013), shared transportation of goods or food (Geissinger et al., 2019), sharing flats, offices or parking spaces (Casado-Diaz et al., 2020; Cohen & Munoz, 2016), sharing a wide range of devices and equipment (Bocker, 2017; Tetrevova & Kolmasova, 2021), sharing finances (Leone & Schiavone, 2018) or sharing various types of services (Yaraghi & Ravi, 2017). Whatever the definition, the fact is that the sharing economy model is associated with a number of positive effects (Teubner, 2014). The main ones being a reduction in demand for new goods (Moriuchi, 2019) and slowing down of environmental destruction (Ravenelle, 2017).

A number of topics are discussed in the context of the sharing economy model. One topic which has so far stood outside the mainstream of research is analysis of the attitudes of participants in the sharing process or other entities concerned towards this phenomenon (Tetrevova et al., 2021). One of the few studies on this is the study by Andreotti et al. (2017a) focusing on selected European countries. This study shows that 90% of Europeans are familiar with the sharing economy model. Respondents from Portugal have the highest level of awareness of this phenomenon (97%), while respondents from Italy have the lowest (82%) (Andreotti et al., 2017a). The only post-communist country included in this research was Poland, where 91% of respondents are familiar with the sharing economy model (Andreotti et al., 2017a). From the point of view of the Czech Republic, one of the few studies is that conducted by IPSOS. This study shows that 38% of the Czech population is familiar with the concept of the sharing economy (IPSOS, 2019). However, respondents' knowledge of individual services is significantly higher, this being as much as 78% in the case of financial sharing via the Zonky platform (IPSOS, 2019). A higher level of knowledge of sharing economy services was found among the younger generation (IPSOS, 2019). Analogous conclusions in terms of the age of respondents were also reached by the Eurobarometer survey (European Commission, 2016) or Andreotti et al. (2017a).

It can be concluded that the current economic situation is leading society to think positively about sharing, and therefore it is reasonable to assume that this model will become more and more important over time thanks to its undeniable benefits. It is precisely these alternative attitudes of individual entities in society towards the sharing economy model which represent an interesting area of research which has not as yet been studied sufficiently.

2. Methodology

The aim of the article is to identify public attitudes towards selected general aspects of the sharing economy model using the Czech Republic as an example. The article presented here aims to answer the following research questions:

1. To what extent is the public in the Czech Republic familiar with the concept of the sharing economy?
2. Does the public in the Czech Republic believe that the sharing economy model will completely replace traditional business models in the future?
3. Does the public in the Czech Republic believe that it is sufficiently informed about the sharing economy and the possibilities of its use?
4. Does the public in the Czech Republic believe that one of the reasons for the limited use of sharing in this country is that people are unable or unwilling to use modern technology?
5. Does the public in the Czech Republic believe that the sharing model is designed primarily for the younger generation?
6. To what extent are attitudes towards the above-mentioned questions influenced by the age of the respondents?

The point of departure for the article was a literature review, which formed the basis for the creation of new findings (Webster & Watson, 2002). This was followed by quantitative research in the form of a questionnaire survey. This is considered to be an efficient method of collecting primary data (Patten, 2014). The pilot survey was conducted in August 2019. The survey was conducted electronically via the LimeSurvey application from September to October 2019. The questionnaire contained four parts, namely a part mapping the respondents' awareness of the sharing economy, previous experience and level of use of sharing economy platforms, public attitudes towards the sharing economy and identification of the respondents. Two closed questions from the section "Respondents' awareness of the sharing economy" and four closed questions from the section "Public attitudes towards the sharing economy" became part of the presented study. Data specifying the respondents are also presented. Respondents were identified using both closed (gender and education) and open (age) questions. Respondents were selected on the basis of quota sampling, with quotas applied to age and gender. The interviewers were students of the University of Pardubice. They contacted the determined number of respondents on the basis of a breakdown of quotas. The sample consisted of 630 respondents. From this sample, 614 fully completed questionnaires were gained. The response rate was 98%. The structure of the respondents can be seen in Table 1 and Table 2.

Table 1. Structure of respondents by age

Age	N	%
15–29	224	36%
30–80	390	64%
Total	614	100%

Table 2. Structure of respondents by sex

Sex/Age	Age 15–29		Age 30–80		Total	
	N	%	N	%	N	%
Male	114	51%	192	49%	306	50%
Female	110	49%	198	51%	308	50%
Total	224	100%	390	100%	614	100%

Primary data were processed using MS Excel (version 2208), specifically with the aid of descriptive statistics tools. Differences in the attitudes of the younger and older generations were tested using Pearson's chi-square test at the 0.05 level of significance.

3. Results

The study first investigated the extent to which respondents were familiar with the term "sharing economy". Table 3 shows that only 23% of respondents know exactly what the term sharing economy means.

Table 3. Knowledge of the term "sharing economy"

Are you familiar with the term "sharing economy"?		
Answer	N	%
Yes, I know exactly what it means	141	23%
Yes, but I don't know exactly what is means	204	33%
Yes, but I have absolutely no idea what it means	102	17%
No	167	27%
Total	614	100%

Respondents were also asked whether they are aware of the existence of the sharing economy model, even though they may not be directly familiar with the concept. For this purpose, the sharing economy was defined as "the temporary provision of currently unused own resources (money, labor, cars, space or things etc.) for use by other entities via digital (online) platforms". Table 4 shows the structure of the responses. In this case, 40% of respondents declared that they were familiar with the existence of the sharing economy model.

Table 4. Familiarity with the existence of the sharing economy model

Have you come across the sharing economy model as defined here?		
Answer	N	%
I definitely have	245	40%
I probably have	210	34%
I probably haven't	114	19%
I definitely haven't	45	7%
Total	614	100%

The study also ascertained respondents' attitudes towards selected aspects of the sharing economy phenomenon. Table 5 shows the respondents' attitude towards the question whether the sharing economy will completely replace traditional business models in the future. The majority of respondents (71%) basically agree with this statement.

Table 5. Attitude towards the statement "The sharing economy will completely replace traditional business models in the future"

Answer	N	%
I definitely agree	131	21%
I probably agree	304	50%
I probably don't agree	141	23%
I definitely don't agree	38	6%
Total	614	100%

Table 6 shows the difference in attitudes between the younger generation (aged 15 to 29) and the older generation (aged 30 to 80). Using the Chi-square test, at the 5% level of significance, there was a statistically significant difference in attitudes towards this statement between respondents who belong to the younger and older generations (Chi-square 16.149, Sig. <0.0005). Respondents belonging to the older generation generally agreed more with this statement.

Table 6. Attitude towards the statement "The sharing economy will completely replace traditional business models in the future" – Differences in the attitudes of younger and older generations

Answer	Relative frequency	
	Age 15–29	Age 30–80
I definitely agree	15%	25%
I probably agree	49%	50%
I probably don't agree	31%	18%
I definitely don't agree	5%	7%

Table 7 shows the respondents' attitude towards the question whether the public is sufficiently informed about the sharing economy and the possibilities of its use. More than ¾ of respondents (78%) believe that the public is sufficiently informed.

Table 7. Attitude toward the statement "The public is sufficiently informed about the sharing economy and the possibilities of its use"

Answer	N	%
I definitely agree	145	24%
I probably agree	331	54%
I probably don't agree	116	19%
I definitely don't agree	22	4%
Total	614	100%

Table 8 shows the difference in attitudes between the younger generation (aged 15 to 29) and the older generation (aged 30 to 80). Based on the Chi-square test performed, there was no statistically significant difference at the 5% level of significance between the attitudes of the younger and older generations towards this statement (Chi-square 3.762, Sig. 0.052).

Table 8. Attitude toward the statement "The public is sufficiently informed about the sharing economy and the possibilities of its use" – Differences in the attitudes of younger and older generations

Answer	Relative frequency	
	Age 15–29	Age 30–80
I definitely agree	24%	24%
I probably agree	51%	56%
I probably don't agree	20%	18%
I definitely don't agree	5%	3%

Table 9 shows respondents' attitudes towards the claim that the sharing economy based on internet platforms is inaccessible to many people because they are unable or unwilling to use modern technology. Most respondents disagreed with this statement. Using a Chi-square test, no statistically significant difference was identified between the attitudes of the younger and older generations towards this statement (Chi-square 3.163, Sig. 0.075) (Table 10).

Table 9. Attitude toward the statement "The sharing economy based on internet platforms is inaccessible to many people because they are unable or unwilling to use modern technology"

Answer	N	%
I definitely agree	32	5%
I probably agree	136	22%
I probably don't agree	266	43%
I definitely don't agree	180	29%
Total	614	100%

Table 10. Attitude toward the statement "The sharing economy based on internet platforms is inaccessible to many people because they are unable or unwilling to use modern technology" – Differences in the attitudes of younger and older generations

Answer	Relative frequency	
	Age 15–29	Age 30–80
I definitely agree	7%	4%
I probably agree	24%	21%
I probably don't agree	40%	45%
I definitely don't agree	29%	29%

Table 11 shows that respondents do not believe that the sharing economy is primarily for young people. However, using a Chi-square test, at the 5% significance level, there was a statistically significant difference in attitudes towards this statement between respondents who are part of the younger and older generations (Chi-square 11.405, Sig. 0.0007) (Table 12).

Table 11. Attitude toward the statement "The sharing economy is primarily for young people"

Answer	N	%
I definitely agree	37	6%
I probably agree	116	19%
I probably don't agree	255	42%
I definitely don't agree	206	34%
Total	614	100%

Table 12. Attitude toward the statement "The sharing economy is primarily for young people" – Differences in the attitudes of younger and older generations

Answer	Relative frequency	
	Age 15–29	Age 30–80
I definitely agree	4%	7%
I probably agree	23%	16%
I probably don't agree	46%	39%
I definitely don't agree	27%	37%

4. Discussion and Conclusions

The study shows that 56% of respondents are familiar with the term "sharing economy", but only 23% of respondents know exactly what this term means. 74% of respondents declared their familiarity with the sharing economy model when the concept was explained to them. The level of familiarity on the part of Czech respondents is therefore significantly lower as compared to the level of familiarity achieved in Western European countries, but also compared to a post-communist country such as Poland (Andreotti et al., 2017a). The

study also shows that the majority of respondents (71%) believe that the sharing economy will completely replace traditional business models in the future. This was supported to a greater extent by representatives of the older generation. Respondents (78%) also believe that the public in the Czech Republic is sufficiently informed about the sharing economy and the possibilities of its use. No statistically significant difference in attitudes towards this aspect was identified between the younger and older generations of respondents. The majority of respondents (72%) disagreed that the sharing economy based on internet platforms is inaccessible to many people because they are unable or unwilling to use modern technology. However, studies to date have shown conflicting views regarding the impact of digital skills on the development of the sharing economy model (Andreotti et al., 2017b). In this case too, no statistically significant difference between the attitudes of the younger and older generations was identified. The study also shows that respondents (76%) do not believe that the sharing economy is primarily for young people. Paradoxically, the older generation were more likely to support this. However, most studies (e.g. European Commission, 2016; Andreotti et al., 2017a; IPSOS, 2019) do show a much more positive attitude towards the sharing economy model from the point of view of the younger generation.

This study expands knowledge of the sharing phenomenon, in particular knowledge about the attitudes of stakeholders, specifically the public in the Czech Republic, towards the sharing economy model. This is a unique study on this topic. There is a very limited number of studies available for possible comparisons, confrontations, and deeper discussions. This knowledge can be used as theoretical points of departure for further follow-up studies in this field which deal with this rapidly developing phenomenon. The findings presented by this study are also useful for managers of sharing economy platforms, and especially for policy makers in this field.

One limiting factor of this study is its focus on one of the small post-communist countries – the Czech Republic. We can also consider the fact that the article does not take into account the effects of the Covid-19 pandemic or the economic effects of the military conflict in Ukraine as a limiting factor. Follow-up studies should therefore focus on comparison from the point of view of the individual countries in Europe or even the world regarding these effects. Another limiting factor is the non-representativeness of the survey, which does not allow for generalization of the findings.

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Happiness or Burden: An Analysis Based on Chinese Household Borrowing Behavior

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Abstract: As one of the main household financial behaviors, borrowing behavior plays an increasingly critical role in economic activities, which has an important impact on household economic welfare and the subjective feelings of individuals. From the data of the China Household Finance Survey (CHFS) in 2017, this paper empirically analyzes the impact of household borrowing behavior on residents' subjective well-being. The results show that borrowing could reduce individual happiness, and this inhibitory effect mainly originating from informal borrowing behavior, while the occurrence of formal borrowing can promote individual subjective well-being. Meanwhile, the development of regional digital finance as well as the enhancement of individual financial literacy can mitigate the inhibitory effect of borrowing behavior on happiness. Further analyses find that when individuals have a cognitive bias on their own debt, that is, when individuals are optimistic about debts exceeding the household ability to repay, happiness will decrease significantly.

Key words: borrowing behavior; happiness; formal borrowing behavior; informal borrowing behavior; financial literacy

JEL Classification: D14; I31

1. Introduction

In recent years, the living standards of Chinese residents have been greatly improved, which is closely related to the high-quality development of China's economy. At the same time, Chinese people desire a more prosperous life, including the demand for material life and spiritual life. According to the World Values Survey, the overall happiness ratio of Chinese showed a large growing trend from 1990 to 2020, and the micro-data based on China Household Financial Survey (CHFS) revealed that the percentage of happy households increased from 56.7% in 2013 to 67.3% in 2019. However, in terms of horizontal comparison, World Happiness Report (2021) released by the United Nations showed that China's happiness index ranks the 72th out of 146 participating countries and regions, with a happiness index 5.585, indicating the sense of residents' happiness still needs improvement.

Neoclassical economics often measure the individual satisfaction or happiness according to utility, meaning that individuals always make behavioral decisions with the objective of maximizing their own utility, hence, the increase in utility brought by individuals in the process or result of the behavior is considered as the improvement of the happiness or satisfaction. As one of the most important financial behaviors of households, borrowing behavior plays a critical role in residents' lives. From a macro perspective, the stability of the leverage ratio of

the household sector is of great significance for economic growth and the orderly operation of macro-economy. From a micro perspective, the acquisition of debt can ease the liquidity constraints, meet current capital needs, and improve individual happiness in life. However, the accumulation of debt could increase the burden and the financial vulnerability of household. That is to say, not only can excessively borrow cause serious psychological and social consequences, the negative externalities it generates may eventually be transmitted to the macro level and even induce the financial crises (Jia et al., 2021; Jeanne & Korinek, 2019). Therefore, household borrowing behavior may bring about an increase in individual subjective well-being, or may lead to a decrease in happiness.

How to correctly guide individual borrowing behavior, maximize the positive impact and reduce the risk caused by borrowing plays a primary role in enhancing the subjective well-being of individuals. Thus, this paper intends to analyze the relationship between household borrowing behavior and individual subjective well-being by using data from the 2017 China Household Finance Survey (CHFS). The contribution to the literature includes three aspects. Firstly, by analyzing the main effect that borrowing behavior has on individual happiness and distinguishing the sources of borrowing, this paper found that formal borrowing can improve individual subjective well-being, while the inhibitory effect comes mainly from informal borrowing, which provides a certain basis for advocating the development of a formal credit market. Secondly, the deviation of subjective and objective debts can reduce individual happiness, by recognizing the subjective debt on whether the family members have repayment pressure, indicating that it is crucial to raise individual awareness of risk in borrowing behavior. The third contribution is to document a significant effect that the development of digital finance and the improvement of individual financial literacy can alleviate the inhibitory effect of borrowing behavior on happiness, thus providing some policy advice about maximizing the effectiveness of borrowing for regions and individuals.

2. Literature Review and Hypothesis Proposition

2.1. Literature Review

Nowadays, with the continuous improvement of financial market, changes in consumption concepts and the diversified needs for asset allocation, borrowing plays a prominent role in household financial behavior, making debt a core composition of household resources (Berger & Houle, 2016). Therefore, the relationship between household debt status and happiness has gradually been paid attention by scholars. Related studies are mostly carried out from two branches. The first strand of literature emphasizes the influence of the actual amount of household debt on happiness, forming two distinct conclusions, “promotion” or “inhibition”. In the “promotion theory”, credit is regarded as a factor of production, which can improve the individual income level. It is documented that borrowing within a reasonable range can effectively improve life satisfaction of individuals. However, once the debt is beyond the range, it may damage personal welfare, accordingly increase household financial vulnerability, and even lead to household debt crisis, that is the view of “inhibition”. The research of Wu et al., (2018) has proved that excessive debt will lead to some rural households

"becoming impoverished due to debt", which may have a detrimental impact on household consumption and individual happiness.

The other strand of literature focuses on individual subjective debt burden, highlighting the negative impact of debt on mental health (Selenko & Batinic, 2011; Keese & Schmitz, 2014). Household debt often causes individual anxiety (Archuleta et al., 2013), such as the repayment pressure, which reduces individual happiness by affecting health (Balmer et al., 2006). Especially for groups who cannot effectively manage the debt, they do not have the ability to achieve their personal goals or improve their consumption capacity and financial flexibility through debt. Instead, it is easy to lead to the accumulation and duration of debt (Clayton et al., 2015), increasing household debt repayment pressure and reducing individual life well-being (Norvilitis et al., 2003).

Overall, as one of the important financial behaviors, borrowing has attracted much attention on individual happiness, and large body of related studies have yielded abundant achievements, but differences in the development situation, cultural background and individual habits of various countries may lead to various manifestations in China. Hence, based on the reality of Chinese household borrowing behavior, it is of certain theoretical and practical guiding significance to explore whether it can improve the happiness of individuals in China.

2.2. Hypothesis Proposition

According to the analysis of existing literature, borrowing can meet the household instant financial needs, and ease liquidity constraints. Besides, through credit acquisition, kinds of activities such as entrepreneurship can increase income, which positively affects individual well-being. Therefore, relaxing credit constraints has positive implications for improving the financial market participation of individuals and enhancing their optimistic expectancy for the future (Luo et al., 2021), illustrating that borrowing has positive effect. However, borrowing behavior is often driven by materialistic pursuits (Crain & Ragan, 2012), rather than improving the household welfare, such groups are more prone to perform conspicuous consumption due to the ratchet effect, which leads to the household taking on more debt for consumption to keep up with the Joneses. These negative effects may increase household financial vulnerability and expose them to greater risks, reducing individual life satisfaction.

At present, irrespective of China's credit market developing and prospering, residents' financial literacy is still relatively poor, and their cognition of financial market needs improving. Some groups are unable to actively and effectively deal with the uncertainty in economic activities, and fail to recognize the risks accompanying household indebtedness reasonably, which limit the positive effects of borrowing due to unreasonable behaviors (Wu et al., 2021). This motivates the first hypothesis, which relates to whether borrowing behavior is associated with lower happiness.

Hypothesis 1: The occurrence of borrowing behavior will reduce individual subjective well-being.

The sources of borrowing behavior include formal and informal. Formal borrowing generally refers to loans from banks and other formal financial institutions, while informal mainly comes from private borrowing, including some debt from non-financial institutions, which generally has the characteristics of short maturity and high interest rate. Although all types of loans are obtained to meet the household immediate financial needs, households under informal borrowing may face much greater repayment pressure, and even crowd out daily consumption due to the time constraint to repay loans (Chen, 2017), which may reduce individual subjective well-being. Most of the debt obtained from relatives and friends do not require interest payment and have no fixed repayment period, but family members will bear a large psychological burden and feel a personal desire to repay in the short term, that is to say, informal borrowing has piled great pressure on individuals, so the happiness effect from such loans is weaker and may even be negative.

In contrast, loans from formal financial institutions generally have longer and fixed terms, furthermore, the institutions have systematically evaluated and confirmed the repayment ability of individuals before their loans are granted, and some of the loans are secured. It indicates that formal borrowing is mostly within the affordable range of the household economic situation, which is with relatively lower repayment pressure. Thus, formal borrowing behavior can effectively play a positive role of indebtedness., this motivates the second hypothesis:

Hypothesis 2: The positive effect of borrowing behavior on happiness mainly comes from the formal borrowing while the negative effect is from informal borrowing behavior.

3. Research Design

3.1. Data Sources and Sample Selection

This paper constructed the sample by using the data from China Household Finance Survey (CHFS), which is conducted every two years by Survey and Research Center for China Household Finance at Southwestern University of Finance and Economics, and it has collected data form six rounds of surveys in 2011, 2013, 2015, 2017, 2019 and 2021. However, the latest survey data in 2021 is not yet fully available, meaning that requests for access to data cover from 2011 to 2019. Meanwhile, considering the research object and specific variables selection requirements in this paper, and ensuring as large a sample size as possible, this paper finally choose the fourth round of surveys in 2017. Given that the head of household knows the most approximately the household economic situation and makes decisions, the samples are restricted to answers from the heads of household. Besides, this paper also obtained data from China Statistical Yearbook for control variables at the provincial level. After excluding samples with missing information about head of the household, missing statistical values of core variables, and abnormal values, a total of 19,177 samples were obtained.

3.2. Variables

1. Explained variable,

Following the related research, this paper uses the index for self-reported values to measure individual subjective well-being. Specifically, the CHFS asks respondents the question to report the level of their happiness: “In general, do you feel happy now?”. One being the least level of happiness and five being the highest level of happiness. Accordingly, option 1 and 2 were assigned to 1, and option 3, 4 and 5 were assigned to 0. So, the variable *Hap* (Happiness) means “are you happy or not”, the value of 1 means happy and 0 means unhappy.

2. Explanatory variables,

The selection of independent variables in this paper includes the following aspects: First, in CHFS, individuals are asked whether they have a loan for any of the reasons, including agriculture, industry and commerce, housing, shops, automobiles, luxury goods, financial products, education, and other factors, so this paper defined a dummy variable *BB* (borrowing behavior). When the household borrows due to any one or more of the nine categories of factors, the indicator of *BB* equals to 1 and 0 otherwise. Second, the question that whether households borrow due to factors including industry and commerce, housing, shops, automobiles, financial products, and education can differentiate the source, so the variable BB_1 (borrowing behavior$_1$) was used to measure whether household borrows due to at least one of the six categories. Third, to test the hypotheses related to the borrowing source, F_BB_1 was generated as a dummy equal to one if household has formal borrowing due to any one or more of these six factors, similarly, a dummy variable IF_BB_1 was defined.

3. Control variables,

Drawing on existing research, other variables may also influence individual subjective well-being either directly or indirectly. Considering the data availability, this paper selected a series of control variables regarding individual level, household level, district and county level, and province level, respectively. Table 1 provides the definitions and measures of the control variables.

3.3. Empirical Strategy

To examine the impact of household borrowing behavior on individual subjective well-being, this paper applied econometric model to testing the hypothesis. Since the explained variable is dummy variable, a discrete choice model is selected, hence, this paper mainly uses the Probit model. The benchmark model is set as follows:

$$Hap_i = \alpha BB_i + \beta Controls_i + \varepsilon_i \quad (1)$$

In the above equation, i represents the individual in the sample, Hap_i is a dummy variable with values of 0 and 1, and BB_i refers to explanatory variable with values of 0 and 1. $Controls_i$ Refers to a set of control variables for the four dimensions of individual level of household head, household level, district and county level and provincial level mentioned above. In order to eliminate the possible heteroskedasticity of the model, indicators such as the

assets, cash, transportation and communication expenses, durable goods expenditure, per capita GDP and per capita disposable income are processed logarithmically.

Table1. Definition and measures of variable descriptions

Variable	Index	Definition
Gender	*Gen*	1 = men, 0 = women
Age	*Age*	Age of the individual
Age squared	Age^2	Age squared of the individual
Marital status	*Mar*	1 = married, cohabiting and remarriage, 0 = unmarried, separated, divorced, and widowed
Health	*Hea*	Measured on a five-point scale, one is the least healthy and five is the healthiest
Education	*Edu*	Years of education
Party	*Par*	Whether the individual is a Communist Party member
Work	*Wor*	Whether the individual has a job
Internet	*Int*	Whether the individual uses the Internet
Social net	*Soc*	Household average monthly local transport and communications costs last year
Asset	*Ass*	Total household assets
Risk preference	*Rpr*	Whether the individual is risk preference type
Risk neutral	*Rne*	Whether the individual is risk neutral
Car	*Car*	Whether the household has a car
Production	*Pro*	Whether the household is engaged in industrial and commercial production and operation
Lend	*Len*	Whether the household has lent
Rural	*Rur*	Whether the household is a rural family
Economic information	*Inf*	Whether the individual pay attention to economic and financial information
Transfer spending	*Tsp*	Whether the household has transfer expenditure
Financial Product Value	*Fpv*	Total value of household financial products
Cash	*Cas*	Total household cash and deposits
Durable	*Dur*	Total value of household durable goods
Gini	*Gini*	Inequality of income for people at the county level
Family Size	*Pop*	The number of people who eat at the same cooking table
Pgdp	*Eco*	GDP per capita at the province level
Unemployment	*Une*	Unemployment at the provincial level
Urbanization	*Urb*	Urbanization rate of the province
Financial Development	*Fir*	(Regional premium income + various deposit balances of banking financial institutions + market value of stocks)/ GDP
U-income	*Uinc*	Per capita disposable income of urban residents at the provincial level
R-income	*Rinc*	Per capita net income of rural residents at the provincial level

4. Results

4.1. Baseline Results

This part first examines how borrowing behavior affects the happiness. The regression results are shown in Table 2, as Columns (1) and (2) reports, after controlling a series of control variables, both *BB* and BB_1 are significantly and negatively associated with happiness, which

means that people are always unhappy with loans. As the marginal effects shows, the borrowing behavior will significantly reduce individual happiness by 2.6%, and the occurrence of household borrowing behavior measured by BB_1 can reduce individual subjective well-being by about 2.5%. Hypothesis 1 can be verified.

Table 2. Baseline regression results

Hap	(1)	(2)	(3)	(4)	(5)	(6)	(7)
BB	-0.026*** (-3.67)	—			-0.028*** (-3.74)	—	-0.032*** (-3.62)
BB_1	—	-0.025*** (-3.24)			—	-0.028*** (-3.33)	—
F_BB_1			0.030* (1.68)				
IF_BB_1				-0.056*** (-3.36)			
Constant	—	—			0.341 (1.09)	0.348 (1.10)	—
N	19,177	19,177	3,900	3,900	19,177	19,177	19,175
R^2	0.072	0.072	0.066	0.068	0.082	0.082	0.064

Note: The values in parentheses in Columns (1) through (4) is Z-statistics, the values in parentheses in Columns 5 through 7 is t-statistics. *p < 0.1, **p < 0.05, ***p < 0.01. Due to space limitations, this paper does not report the regression results of relevant control variables. The same below.

4.2. Empirical Analysis Based on Differences in Debt Sources

To test the hypothesis 2, borrowing behavior was divided into formal borrowing behavior (F_BB_1) and informal borrowing behavior (IF_BB_1), this part mainly examines their differential impact on happiness. From the regression result in Column (3) of Table 2, formal borrowing behavior can significantly improve individual happiness by about 3%. On the contrary, the results in Column (4) indicate that the informal borrowing behavior leads to a significant decrease in happiness by 5.6%, and the absolute value of the coefficient shows that this effect is greater than the positive effect of formal borrowing, which leads to the inhibitory effect of borrowing behavior on subjective well-being to some extent. Hypothesis 2 can be verified.

5. Further Analysis

5.1. Analysis Based on Subjective Debt and The Deviation Between Subjective Debt and Objective Debt

Borrowing behavior directly leads to the generation of debt. In general, debt repayment pressure will bring mental health shocks (Brown et al., 2005), leading to a reduction in individual happiness. For example, Crain & Ragan (2012) points out that materialists are more likely to consume beyond their financial means, which are not conducive to the improvement of household welfare. What is more, some household debts have risks beyond the household financial capacity, and they may be overly optimistic about the debt situation due to their inability to correctly perceive the current situation of household debt. In other words, when individual subjective perception of the current situation of household debt deviates from the objective facts, they may act in ways that exacerbate the risk of household debt and damage household welfare, leading to a decrease in the individual well-being.

Based on the above analysis, there are two problems need to be empirically analyzed. One is to investigate whether happiness could be driven by the subjective debt, and the other is to explore how the deviation between perceived and actual debt affects individual subjective well-being. Referring to previous studies, subjective debt is always quantified by debt repayment pressure, and in the CHFS data, there is a related question designed in the relevant mortgage loan module: "At present, how is your household economic capacity of repaying the monthly installment? ① There is no problem at all. ② There is basically no problem. ③ It is difficult to repay. ④ Absolutely impotent". Since most households with debts have a large proportion of mortgage loans, and the repayment pressure of other debts in the database cannot be effectively measured, it is adopted as a proxy variable for household subjective debt whether individuals deem that there is repayment pressure (*SD*). Options ③ and ④ are assigned a value of 1, that is, the individual has repayment pressure, and options ① and ② are assigned a value of 0, indicating that the individual has no repayment pressure. The regression results with household subjective debt as the explanatory variable are shown in Column (1) of Table 3, showing that the group with high repayment pressure is inclined to lower happiness, and compared with the group with less repayment pressure, their happiness significantly reduces by approximately 11.9%.

Researchers often use the debt-to-income ratio to measure the real debt. Taking into account the availability of the CHFS data, this paper mainly calculates the ratio of monthly mortgage repayments to monthly household income. According to the personal loan regulations for national commercial housing in China, it is appropriate to measure whether household have debt burden at an objective level based on whether the ratio exceeds 50% (the loan conditions will not be met if the proportion exceeds 50%). If the debt-to-income exceeds 50%, while the individual does not think he has debt burden, it is defined as a deviation (*Dev*) between the individual subjective perception of the household debt status and the objective fact, assigning the value 1, otherwise 0. Column (2) of Table 3 explores the effects of the deviation on happiness, indicating that once there was a deviation between the subjective and objective debts, the individual happiness would significantly reduce by 5.9%. It is thus conspicuous that individuals who are overly optimistic in the face of debt may engage in risky behavior beyond the household financial situation, which can negatively impact the individual subjective well-being.

5.2. The Moderating Effect of Digital Finance

At present, the rapid development of digital finance has made up for the shortcomings of traditional finance, mitigates the information asymmetry in the market, and accurately captures customers' information based on big data accurately. Conspicuously, the investigation of the borrower's loan qualifications increases the rationality of borrowing and ensures the security of the debtor's funds. Besides, the intelligent credit approval saves the borrower's time and cost, and improve the probability of their loan success while ensuring that the debtor has the potency to repay, alleviating the uncertain impact of borrowing behavior in

the traditional financial environment, lessening the decline in happiness caused by borrowing behavior to some extent.

Based on the influence of household borrowing behavior on subjective well-being, this part mainly delves the moderating role of digital finance in it. Taking into account the hysteresis of the impact, this paper uses the province-level digital financial inclusion index in 2016 published by the Digital Finance Research Center of Peking University (Guo et al., 2020), the digital financial inclusion index was divided by 100 to measure the degree of development of digital finance (*IF*), and the interaction term (*BB*IF*) between digital finance and household borrowing is also included in the regression. Columns (3) and (4) of Table 3 shows that the development of regional digital finance can alleviate the negative impact of borrowing behavior on individual happiness, and each increase of 100 in the digital financial inclusion index in the local area alleviates the inhibitory effect of borrowing behavior on happiness by about 5%.

Table 3. The results based on further analysis

	(1)	(2)	(3)	(4)	(5)	(6)
SD	-0.119*** (-5.54)					
DEV		-0.059* (-1.87)				
BB			-0.145** (-2.26)	—	-0.035*** (-3.38)	—
IF			-0.181*** (-3.02)	-0.193*** (-3.26)	—	—
*BB*IF*			0.050* (1.86)		—	—
BB_1			—	-0.304*** (-3.46)	—	-0.043*** (-3.83)
BB_1**IF*			—	0.119*** (3.17)	—	—
FK			—	—	-0.009 (-0.72)	-0.011 (-1.06)
*BB*FK*			—	—	0.015 (0.81)	—
BB_1**FK*			—	—	—	0.036* (1.73)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	2846	912	19177	19177	12351	12351
R^2	0.066	0.064	0.072	0.072	0.075	0.075

Note: The values in parentheses are Z-statistics. *p < 0.1, **p < 0.05, ***p < 0.01.

5.3. The Moderating Effect of Financial Literacy

Studies on household behavior decision-making always emphasize the importance of financial literacy (Yin et al., 2014). As far as borrowing behavior is concerned, the liabilities are risky, especially for groups devoid of financial literacy, who have got a smattering of experience with finance, unable to deal with uncertainty, and are more likely to be over-indebted (Lusardi & Tufano, 2015). Conversely, groups with higher financial literacy generally have better capital management capabilities and risk awareness, who can optimize their financial situation as much as possible, ensure the household debts are within control, and

responding to uncertain situations timely. Thereby, they may reduce the detrimental effects caused by the borrowing behavior.

Therefore, this paper further explores the moderating effect of financial knowledge level in the effect of borrowing on subjective well-being. There are five questions to measure individual financial knowledge in the 2017 CHFS: H3105: Suppose the annual interest rate in the bank is 4%, if you put 100 yuan into a one-year deposit, what is the principal and interest you will get after one year? ① less than 104 yuan, ② equal to 104 yuan, ③ more than 104 yuan, ④ can't figure it out; H3106: Suppose the bank's annual interest rate is 5% and inflation is 3% a year, what can I buy in a year if I put 100 yuan in the bank? ① more than a year ago, ② as much as a year ago, ③ less than a year ago, ④ can't figure it out; H3111: Which do you think is riskier in general, stocks or funds? ① stocks, ② funds, ③ never heard of stocks, ④ never heard of funds, ⑤ neither has ever been heard of, ⑥ the same size. Based on these questions, two or three correct answers are assigned a value of 1 (financial knowledge level is high) and the others are assigned a value of 0 (financial knowledge level is low), so the variable *FK* is generated. Columns (5) and (6) of Table 3 shows that the interaction coefficient is positive but not significant. Further taking BB_1 as an explanatory variable, and adding its interaction term with financial knowledge level, the result shows that the coefficient of interaction term is significantly positive, indicating that individuals with full-fledged knowledge of finance can significantly mitigate the inhibitory effect by approximately 3.6%.

5.4. Robustness Test

To further test the robustness of the baseline results, this paper also conducts foregoing analysis by using different model and replacing explanatory variables to verify the impact of borrowing behavior on individual subjective well-being.

First, the empirical method was altered. Least Squares Regression (OLS) was deployed to re-examine the impact of household borrowing behavior on happiness. The regression results with *BB* and BB_1 as the core explanatory variables are shown in Column (5) and (6) of Table 2, the coefficients are negative and significant at 1% level, suggesting that borrowing could lead to lower happiness, confirming the robustness of the baseline model estimate.

Second, the propensity matching score method (PSM) was used to do this test. Another important factor that may interfere with the reliability of the baseline results is the self-selection problem. That is, when the research plunges into the impact of household borrowing behavior on happiness, the occurrence of borrowing behavior and individual happiness may be affected by some variables not included in the empirical model at the same time, resulting in the self-selection problem of the sample households with borrowing behavior. Referring to the practice of Chen (2017), the PSM is used to match the borrowing behavior with the households that do not have borrowing behavior according to multiple characteristics, and through the counterfactual test, the net effect of household borrowing behavior on individual subjective well-being is stripped out. As Column (7) in Table 2 shows, the adjusted ATT is -0.032 after the regression based on sample weight substitution, and it passes the test at the 1% significance level, indicating that the negative effect of borrowing behavior on happiness is robust.

Third, the explanatory variables were replaced. Borrowing directly leads to household debt, so, this part examines the impact on happiness based on the actual amount of household debt. The variable *Debt* is reported in the CHFS database, representing the actual amount of household debt, which is added by 1 and logarithmic. According to the previous discussion, only some debts can distinguish the source, therefore, the debts that can distinguish the source are added up, the value is added by 1 and the logarithm is processed to generate the variable $Debt_1$. Furthermore, this part also examines the effect of the proportion of debts based on formal borrowing to total debts (F_Debt_1) and the proportion of informal borrowing-based debt to total household debt (IF_Debt_1) on happiness. As shown in Column (1) of Table 4, each unit increase in the logarithm of debt reduces individual happiness by about 0.3%. As columns (3) and (4) shows, the coefficient of the proportion of formal debt to household debt is significantly positive, meaning that higher formal debt ratio is associated with higher happiness in individuals. In contrast, the increase in the proportion of informal debt reduces subjective well-being at the 5% significant level, so the aforementioned conclusions are robust.

Table 4. Robustness checks for replacing the explained variable

	(1)	(2)	(3)	(4)
Debt	-0.003*** (-4.65)	—	—	—
$Debt_1$	—	-0.002*** (-3.10)	—	—
F_Debt_1	—	—	0.035** (2.03)	—
IF_Debt_1	—	—	—	-0.047** (-2.40)
Controls	Yes	Yes	Yes	Yes
N	19,177	19,177	3,879	3,879
R^2	0.072	0.072	0.066	0.067

Note: The values in parentheses are Z-statistics. *p < 0.1, **p < 0.05, ***p < 0.01.

6. Conclusion and Discussion

Promoting people's living standard is an important part of achieving common prosperity, and the enhancement of individual happiness is of great significance for improving people's livelihood and well-being. As one of the main economic behaviors, borrowing has a decisive impact on behavior decision-making, capital flow, economic status and subjective feelings.

This paper empirically investigates the impact of household borrowing behavior on individual subjective well-being through the CHFS data in 2017, the results show that borrowing behavior inhibits the improvement of individual happiness, and the negative impact mainly originates from informal borrowing, while formal borrowing can significantly enhance the subjective well-being. In addition, this paper also plunges into how the subjective debt burden and the cognitive bias affect happiness, the result shows that those who perceive their greater debt repayment pressure have a significant inhibiting effect on happiness, and the cognitive deviation of subjective and objective debts also decreases the well-being. This result may explain that borrowing restrains happiness mainly due to the psychology stress of debt, particularly in China's relation society, informal borrowing probably contributing to greater debt repayment pressure. The other

explanation is someone cannot correctly recognize their debt status, and they keep optimistic about the debt exceeding household solvency. Besides, to offer insights into some of the moderating effects possibly driving the negative effect between borrowing and happiness, this paper further probes into the digital finance and individual financial literacy, the result shows that the rapid development of regional digital finance and the improvement of individual financial literacy can significantly alleviate the inhibitory effect of household borrowing behavior on happiness.

The empirical results contain several strong policy implications. The first is to regulate the credit market. It is important to accelerate the development of the formal credit market, especially with the rapid development of digital finance, and improve the availability of credit for individuals who have the demands and then meet loan qualifications relying on digitization, artificial intelligence, etc. Besides, the normative development of informal credit should be actively guided to promote the diversification of the credit market. For instance, it is necessary to establish and improve relevant laws and regulations on private credit, encourage the healthy development of private financing, gradually incorporate private financial institutions into the regulatory system in due course, protect the legitimate rights and interests of consumers. The second is to strengthen the popularization of financial knowledge, improve the individual financial literacy. This helps to deepen individual understanding of the financial market, and guide individuals to make correct financial decisions, therefore, avoiding the debt pressure and cognitive deviation caused by greater debt burden.

Conflict of interest: none

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On-the-Job and Off-the-Job Training in European Companies Context

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Abstract: Companies face unexpected changes in an economic, social, and global environment. Their training and development activities could overcome this uncertainty and support their innovation power. Selecting a suitable form of training affects the company's competitiveness and is one of the essential issues of the company's success. Therefore, the European statistical office regularly conducts a Continual Vocational Training Survey (CVTS) over five years. The survey collects data about training and development activities in enterprises with more than ten employees in 29 European countries. The paper uses CVTS data to analyse the training activities in the workplace over 15 years. It focuses on the intensity of training and methods used in companies. The findings reveal different approaches in selected individual countries and time development. Thus, the article brings new research questions to the human capital investment topic.

Keywords: enterprises; on-job training; off-job training; European Continual Vocational Training Survey

JEL Classification: M12; M53; 015

1. Introduction

Globalisation, technological progress, and crises challenge companies and their training and development systems. As Vasanthi and Basariya (2019) point out, employee training is essential and unavoidable for the growth of an organisation. The idea underlying this assumption is that training plays a key role in enhancing two of the main sources of competitive advantage for the firm: its human capital and its organisational knowledge (Aragon et al., 2003; 2014). The acquisition of training and skill has been seen as a long-term strategy on part of either the employer or the employee, overlooking the immediate requirements of the job in which the employee is currently working (Korpi & Tåhlin, 2021). It is an essential part of the organisational learning (OL) approach. As Aragón points out, one of the approaches to OL defines it as a process by which organisations learn and develop new knowledge. This process is integrated by another four sub-processes: knowledge acquisition, distribution, interpretation and memory (Huber, 1991).

The COVID-19 pandemic hindered training in enterprises and posed significant challenges for training (OECD, 2021). Training and development lead to a broad spectrum of economic and social benefits, such as innovation (Makkonen & Lin, 2012), improved health and well-being of employees, and better adaptation to changes (OECD, 2021). Training and development affect the company's productivity (De Grip & Sauermann, 2013). Therefore,

firms should carefully plan investments in these activities with a long-term view and systematic approach (Vodák & Kucharčíková, 2011). The provision of training is changing, there is a shift in delivering of training, especially a shift to online is more evident (CEDOFOP, 2022).

This paper investigates the training activities from the perspective of the organisation. The comparative time analysis could reveal the essential feature of present corporate training in Europe. It also aims to analyse progress and change in providing on-the-job or off-the-job training in European companies.

1.1. Training and Development in Companies: A Literature Review

The choice of training method illustrates one of the most crucial decisions in training planning (Koubek, 2012; Jevana, 2017). The wide range of training and development activities divide into two main groups – on-the-job and off-the-job. Over the past decade, there have been changes in training methods due to increased learner's needs, advancements in technology and increasing trends in mobile technology (Jevana, 2017). According to Bafaneli and Setibi (2015) there has been a significant rise in on-the-job training for several decades. Training and development activities are divided into on-the-job and off-the-job training. Off-the-job training is provided for a group of participants outside their workplaces. In addition to traditional classroom training, learning by doing is becoming a future trend (Innovation Training, 2020). Based on the survey that was carried in the UK revealed that about half of the training delivered across all industries and sectors happens through on-the-job training. Studies have shown that on-the-the-job training is crucial in the improvement of the requisite skills of employees. Studies have shown that on-the-the-job training is crucial in the improvement of the requisite skills of employees (Orrje, 2010). On-the-job training (on the job or on-job) illustrates methods of training and development that take place at the workplace and connect to job tasks. This method has made a significant impact in the industrial sector. A structured on-the-job affects the worker and the entire organisation (Ahadi & Jacobs, 2017). On-the-job methods often involve work instructions, coaching, mentoring, job rotation, counselling, apprenticeship, task assignment, meetings, learning by doing, and self-directed or self-managed learning. Work instruction is a guided on-the-job activity directly provided at the workplace. Coaching establishes questions between a coach and an employee. Mentoring is based on the advice of an expert to an employee. Apprenticeship is time spent with a more experienced colleague. A task assignment targets some specific task solved with a senior co-worker. Job rotation means a change in a job position or workplace. Meeting with colleagues from different departments illustrates a cross-knowledge exchange in a company (Koubek, 2012). Self-directed or self-managed learning encourages individuals to take responsibility for their learning needs to improve performance in their present job or to develop their potential (Armstrong & Taylor, 2014). This individual approach represents the main feature of on-the-job training. Personalised training tailored to employee-specific learning belongs to one of the announced trends in training and development for the future (Innovation Training, 2020).

There are several international studies related to vocational training in the international context. One complex analysis of the topic was introduced in Wieringen and Attwell (2013). For the analytical part of the paper, data from the Continuing Vocational Training Survey (CVTS) are used. The CVTS (2023) defines Continuing vocational training (CVT) as "training measures or activities which have as their primary objectives the acquisition of new competencies or the development and improvement of existing ones. It should be financed at least partly by the enterprises for their persons employed who either have a working contract or who benefit directly from their work for the enterprise, such as unpaid family workers and casual workers."

Contrarily, the off-the-job training is mainly provided for a group of participants. These off-the-job activities often take place outside the company and include internal training. The most used off-the-job methods include classroom training, business game or role-playing, workshops, adventure education, and case studies. A classroom or vestibule training occurs at a specific place, mostly face-to-face. A business game and role-playing target specific soft skills in the form of a game. Workshops or group exercises are case studies that solve some specific issue. Outdoor training is learning by movement, mostly solved collectively. A case study analyses a specific or complex topic in depth. Most methods are off-the-job (Martin et al., 2014; Ahadi & Jacobs, 2017). Experiential learning (or learning by doing) is one of the trends for the future in training and development (Innovation Training, 2020). The European Union is aware of the importance of vocational training in enterprises. Therefore, the European statistical office (EUROSTAT) regularly conducts Continual Vocational Training Survey (CVTS) over five years This survey collects information about training and developing activities financed (or at least partly funded) by enterprises with more than ten employees in 29 European countries.

2. Methodology

This paper is based on the literature review of the topic training and development in companies and represents findings from a quantitative analysis comparing results from European Continuing Vocational Survey (CVTS) in reference years 2005, 2010, 2015, and 2020. Data was obtained through Eurostat online data browser, whereby European data from the reference year were published in January 2023. Data is collected based on Commission Regulation No 1153/2014 of 29 October 2014, amending Regulation (EC) No 198/2006n. In general, this survey is mandatory for 27 countries of the European Union and was also conducted in Norway and Serbia. Therefore, CVTS enables analysing results in time, place, and an international comparison with another European countries. Employees holding an apprenticeship or training contract should not be considered for CVTS. The training measures or activities must be planned in advance and organised or supported with the special learning goal. Random learning and initial vocational training (IVT) are explicitly excluded. CVT measures and activities cover both CVT courses and other forms of CVT.

The survey CVTS regularly collects information about enterprise training activities in seven sections which cover data about providing a continuous vocational training (CVT) activity, CVT strategy implementation, then information about participants, costs, time,

characteristics, and assessment of CVT. The paper focuses on several aspects and aims to provide on-the-job or off-the-job activities from a time perspective.

All asked training methods are divided into CVT courses and other forms of CVT. CVT courses are typically clearly separated from the active workplace. Learning occurs in locations specially assigned for learning, like a classroom or training centre. They show a high degree of organisation (time, space, and content) by a trainer or a training institution. The content is designed for a group of learners. All other training activities which meet CVT definition are called Other forms of CVT.

The survey CVTS (2023) defines, "Other forms of CVT are typically connected to the active work and the active workplace, but they can also include participation (instruction) in conferences, trade fairs etc. for the purpose of learning. These other forms of CVT are often characterised by a degree of self-organisation (time, space, and content) by the individual learner or a group of learners. The content is often tailored according to the learners' individual needs in the workplace. The following types of other forms of CVT are identified as planned training through guided-on-the-job training; planned training through job rotation, exchanges, secondments or study visits; planned training through participation (instruction received) in conferences, workshops, trade fairs, and lectures; planned training through participation in learning or quality circles; planned training through self-directed learning/e-learning." Based on the literature review, the authors off-the-job comparable with the CVT course, and on-the-job activities are similar to the other forms of CVT excluded categories with conferences and fair trades. This analysis compares first the ratio of *training enterprises* which provide at least one planned CVT activity in the reference year and has a minimum of ten employees. According to the statement of CVTS, most countries for CVTS three to six conducted their surveys in line with the regulations for reference years 2005 (CVTS3), 2010 (CVTS4), 2015 (CVTS5), 2020 (CVTS6) and reported no significant processing errors. Comparing the different waves of CVTS, some changes were implemented to improve the quality of CVTS and better legislation adaptation. These changes did not seriously impact the comparability between the waves since 2005 (CVTS, 2023).

Based on the literature review and secondary data, the authors set two research questions, RQ1 and RQ2. These questions help to answer and map organisations' attitudes toward training and development and the methods these organisations use to train employees.

- RQ1: What attitude to training and development do European companies apply?
- RQ2: Which training methods (on or off-the-job) do European companies prefer?

To answer these questions, data from CVTS in four reference years were used to compare organisations in European countries as well as identify the main differences.

2.1. Data Sample

The survey CVTS covers all enterprises with ten or more employed persons in the most NACE categories. Although NACE categories were slightly adapted in 2010, data should be comparable from 2005 to 2020. The CVTS is a sample survey; therefore, the results include the

usual statistical measurement errors. According to the quality statement of CVTS, the accuracy of data should be overall satisfactory, and the national submitted data pass the validation of EUROSTAT. Table 1 presents the number of relevant enterprises for the specific CVTS and the response rate for the reference year. The total number for CVTS6 is not yet published.

Table 1. Number of enterprises in CVTS for specific reference year (EUROSTAT, 2023)

CVTS (Reference year)	Net sample size/ number of participating enterprises on survey
CVTS3 (2005)	78,000
CVTS4 (2010)	101,000
CVTS5 (2015)	111,000
CVTS6 (2020)	N/A

The authors analyse the main trends in on-the-job and off-the-job training in European countries. Due to satisfactory data relevance gained in 29 European countries, the survey CVTS illustrates an appropriate data set. According to research questions and for better visibility, the paper emphasises results based on this concept:

- the first or three first-ranked countries in the reference year 2020,
- the last or three last-ranked countries in the reference year 2020,
- EU 27, an average of 27 countries, which are state members EU from 2020,
- the Czech Republic (Czechia), it is not involved as the first or the last ranked country
- EU 27 represents the mainstream in the reported year, if some data is missing then the following country with comment.

3. Results and Key Findings from the CVTS Survey

This chapter introduces selected findings to answer the research questions about what attitude to training and development European companies have and which training methods (on or off the job) European training companies prefer. All are compared in the time context to find the positions of Czech organisations in the training and development of employees.

3.1. Ration training Companies in Europe

Proportion of organisations which provide training in Europe differs significantly. Figure 1 presents the proportion of enterprises which provide training to all relevant European enterprises in 2020. Figure 1 shows the EU-27 average and three countries listed on the top and in the bottom of the ranking list in 2020 expressed in percentage. The Czech Republic, with 85.9%, is ranked fourth. It means that 85.9% of enterprises invest and provide some training and development to employees.

The average of 27 EU countries (EU 27) declares 67.4% training enterprises and ranks 18th place from a total of 29 countries. Latvia is the best-ranked country in 2020, where 96.8% of all enterprises are training enterprises. It means that almost all companies in Latvia provide a minimum of one planned training activity to their employees. Norway keeps with 93% second place, and Sweden 91.5% is third place.

On the contrary, with 17.5% of training companies, Romania represented the last rank in 2020. From this it is deducted that 82.5% of Romanian companies provide no single planned

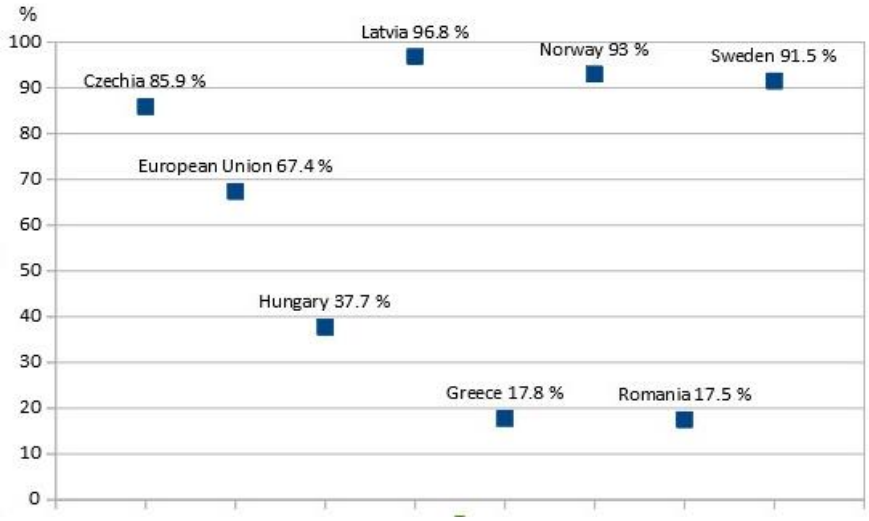

Figure 1. Ratio (%) of training companies to total enterprises in 2020 (CVTS, 2023)

training activity or measurement. A similar situation is reported in Greece, with 17.8% training enterprises and 82.2% non-training enterprises. Hungary is the third last ranked country with 37.7% training enterprises. Five European countries declare between 40% and 49%. Twenty-two asked European countries represent more than 54% of training companies. The complete ranking of training enterprises is available on websites of European data browser (EUROSTAT, 2023).

Figure 2 below illustrates the time changes in on-the-job and off-the-job training in selected countries. For the change presentation over time, the average of 27 EU countries, the best and worst ranked countries, and Czechia were selected. The 27 EU average shows a slight increase from 55.6% to 70.5%. Due to the COVID pandemic, there was a decrease in 2020 to 67.4%. Latvia, in the first place, shows a sharp increase between 2010 and 2015, by 59.4% in total. The Czech Republic reports an increase of 18.4% in this period. Overall, since 2005, 72% of training enterprises reached 85.9% of training enterprises. Romania shows a negative trend, with Europe's worst training ratio to non-training enterprises in 2020. In 2005 Romania reported 36.4% of enterprises training. In 2020 it was only 17.5%. Overall, between 2005 and 2010, most countries experienced a positive trend, with the EU27 average increasing by 8%.

Due to the economic crisis, Romania is experiencing a rather significant decline. The increase between 2010 and 2015 can be explained by the economic recovery and increasing innovation in the context of technological progress. The decline in the last period is marked by the COVID pandemic, which has dampened planned activities in education and development.

Figure 3 shows the training enterprises and types of off-the-job training activities. The most commonly used training method mentioned by respondents was a course. Over 81.5% of training enterprises plan courses on a long-term basis. Compared to 2005, there was a slight decrease; 83.6% of training enterprises used a course as a planned development activity for their employees. There was a slight increase in 2010 and a slight decrease in 2015. Clearly, while this is quite a popular development method, the figure shows that this proportion is more likely to decline in the long term but is unlikely to be used anymore. Regarding on-the-job

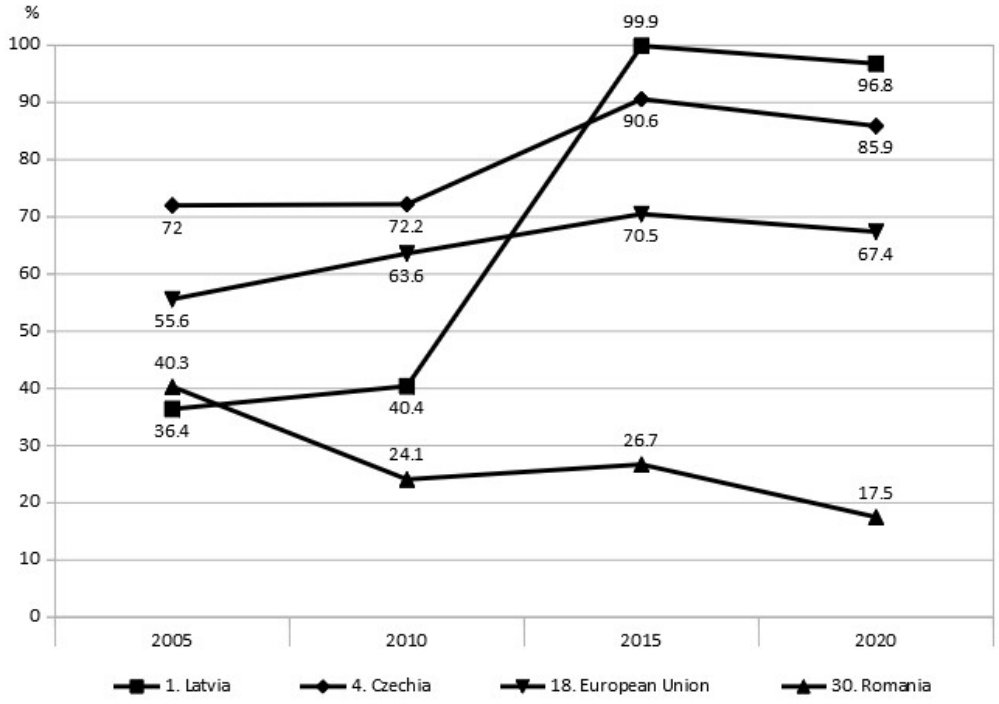

Figure 2. Change of providing of on-the-job and off-the-job training in training enterprises in selected European countries in year 2005, 2010, 2015, 2020 (CVTS, 2023)

methods, this needs to be broken down more by the nature of the individual activity. In the case of guided on-the-job, this is a widely used method. In 2005, 49.4% of training companies used this method. Despite a slight decrease of 1.2% in 2010, there was an increase of 10.3% between 2010 and 2015. This increase is mainly driven by certain countries, as the analysis below will show. In 2020, 63.9% of training companies used the guided on-the-job method, the second most used on-the-job method. That reflects the trend towards individualisation also in training, a development linked directly to the workplace.

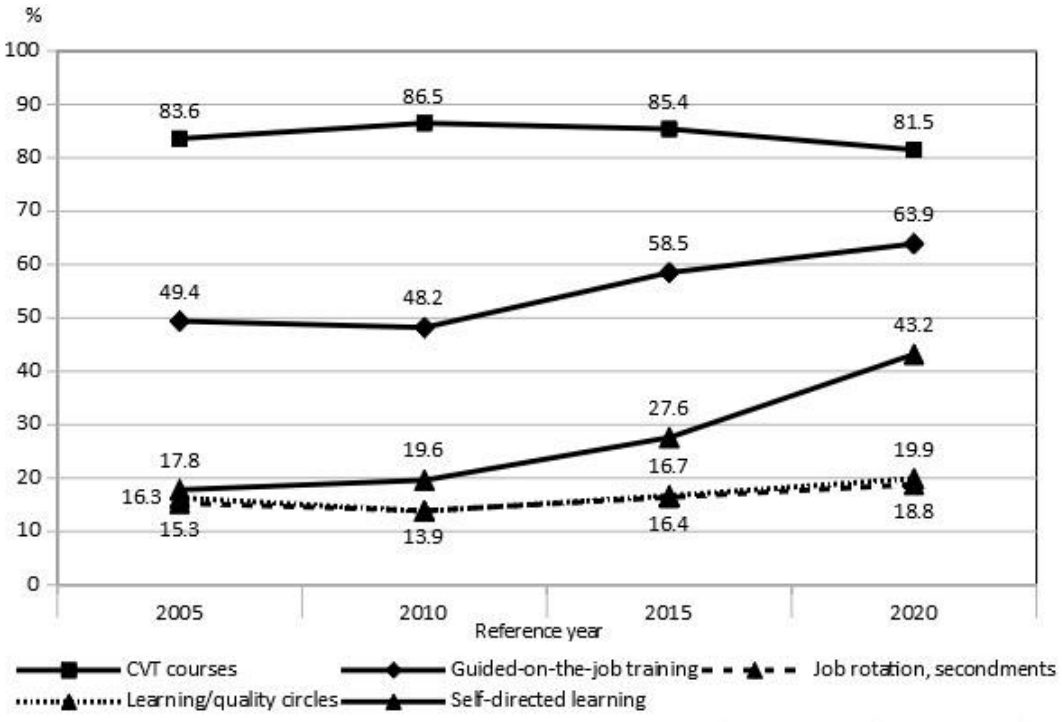

Figure 3. Types of on/off-the-job training activities, an average of 27 EU countries (CVTS, 2023)

The self-directed method and e-learning are the only ones showing continuous growth among the mentioned methods. In 2005, 17.8% of training companies used this method. An increase of 1.8% in 2010, and 27.6% in 2015 already reported using it, probably due to the proliferation of individual e-learning courses. In 2020 and thanks to the COVID pandemic, 43.9% of training companies are using it as a planned development activity.

Globally, almost the same proportion of training companies use job rotation, learning, and quality cycle methods. Despite a slight decrease in the use of this method in 2010, there was a slight increase in subsequent periods. Job rotation was used by 15.3% in 2005 and 18.8% in 2020. In the case of the quality ring and similar on-the-job methods, this is 16.3% in 2005 and 19.9% in 2020.

3.2. Providing Off-the-job Training in European Enterprises

The most common method of the off the job continuous vocational training in Europe is provided in the form of courses. CVT courses take place out of the working place and are often designed for a group with a high degree of formal organisation.

Figure 4 indicates that Czech training companies use the CVT course as the method the most. In 2015, 98.7% of Czech training enterprises used this method. In 2020, there will only be a decrease of 0.2%. That compares to the EU27 average of 81.5% in 2020, 85.4% in 2015, and relatively stable values over the long term.

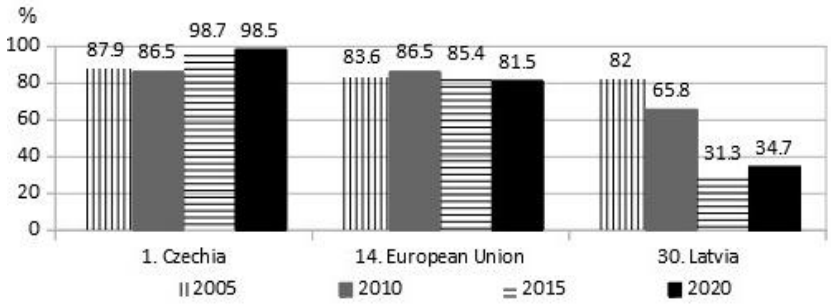

Figure 4. Ratio (%) of enterprises providing CVT training to all training enterprises (CVTS, 2023)

The country with the lowest number of training companies using the course method, i.e., the off-the-job method, is Latvia. From an initial 82% in 2005, there has been a decline to 31.3% in 2015. In 2020, the use of the course method in Latvia grew by 3.3%.

3.3. Providing On-the-job Training in European Enterprises

On-the-job training is a planned development activity associated with a degree of self-organisation. The content is adapted more to the needs of an individual learner. European training companies mostly use guided on-the-job training in the workplace. In comparison with the previous outcomes, the situation is reversed. Figure 5 shows that all training enterprises in Latvia use guided on-the-job training. The EU27 average has also seen a gradual increase since 2010. In 2015, 63.9% of training companies used this method. Surprisingly, in the case of the Czech Republic, the trend is the opposite. If we compare the data from 2010, 58.2% of training companies used this method, but in 2020 only 29.7%

declared using on-the-job training. Firms' attitudes toward using job rotation, exchanges, secondments, or study visits confirm that Sweden tops the ranking for 2020 with 36.1%, but there is missing data for 2015 and a low confidence note for the other data. Therefore, the Netherlands is listed here, ranked second with 32.6% in 2020. As Figure 6 shows, relatively few companies in the Czech Republic use this method. In contrast, 18.8% of training firms in the European Union used this method in 2020. In the Netherlands, it is even 32.6% of training companies. Here, it depends on the willingness of employees to change location, commute, or otherwise be flexible. If we look deeper into the on-the-job methods, the most common in European enterprises are participating in learning or quality circles. These methods are often used in the manufacturing industry. Interestingly, this method slightly increased in the European Union, with 19.9% of companies using this method in 2020. Moreover, it ranked up to the 21st position with this value. Thus, most European countries use this method in at least a fifth of training companies.

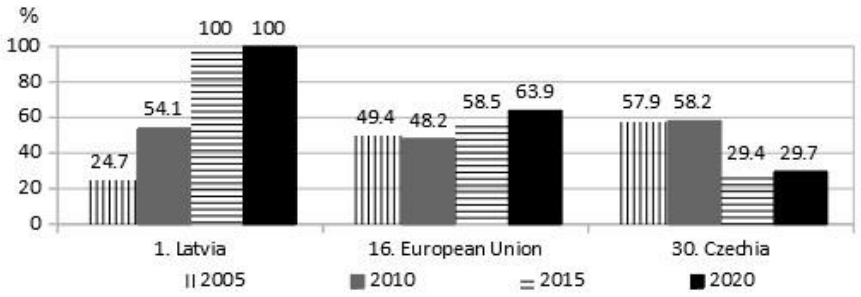

Figure 5. Ratio (%) of enterprises providing a guided on-the-job training to all training enterprises (CVTS, 2023)

In the Czech Republic, on the other hand, fewer and fewer companies are using this option. In contrast, Finland has seen a significant increase, with 41% of training companies using this method in 2020 (see Figure 6).

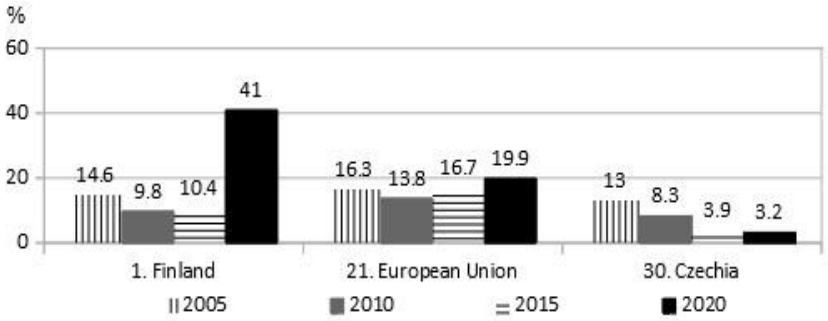

Figure 6. Ratio (%) of enterprises providing a learning or quality circles to all training enterprises (CVTS, 2023)

Thanks to increasing digitalisation and the COVID-19 pandemic, there has been logically a significant increase in self-directed learning methods, primarily through e-learning. This activity is planned by an average of 43.2% of training companies in the EU in 2020. Ireland reported that 64.3% of training companies provide this method but needs a figure from 2010. Therefore, the study mentions the Netherlands, which was in second place with 62.5% in 2020.

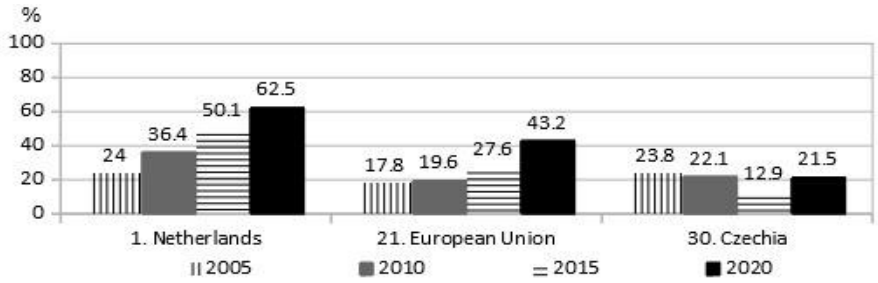

Figure 7. Ration (%) of enterprises providing a self-directed learning methods, e-learning to all training enterprises (CVTS, 2023)

Data in Figure 7 also show in the Czech Republic a positive trend, increasing from 12.5% to 21.5% in 2020. Although a fifth of Czech training companies report using this method, it is in last place in the country overview. That is in contrast to course delivery, which ranks first with 98.5%.

4. Discussion

Training and development is a significant investment that affects company performance (Alipour et al., 2009; Dardar et al., 2012; Martins, 2021), innovation (Makkonen & Lin, 2012) and promotes adaptation to unexpected changes (OECD, 2021). The training method illustrates one of the most crucial decisions in corporate training and can be classified by two main groups – on-the-job and off-the-job training. This paper examines the situation in European countries. Data from the Continuing Vocational Training Survey (CVTS) were analysed to understand European companies' situation in the last years. The survey is mandatory for participating countries conducted by Eurostat every five years. The sample of respondents counts 111,000 European companies with more than 10 employees in 2015. This paper compares data from 2005, 2010, 2015 and 2020. The results of this data analysis confirm the importance of training and development for European companies and provide answers to two research questions set in chapter 2. Based on the RQ1 authors looked at the situation in the training intensity in European organisations. The highest number of firms providing at least one training or development activity was in Latvia (96.8%) in 2020, with a significant increase between 2010 and 2015. Czechia has a relatively stable development being in fourth place (85.9%) in 2020, above the EU 27 average (67.4%). The lowest ratio of training companies shows Romania (17.5%). As the diverse approach in the literature to appropriate training methods, findings presented in the paper show that European countries vary significantly in the intensity of employee training and methods the companies use for it. RQ2 aimed to map the methods used for training in Europe. Although most Latvian and Czech companies train their employees, a different training method is preferred in each country. Czech firms prefer mostly off-the-job methods. Contrarily, Latvian companies prefer on-the-job methods. The average of 27 European countries shows that off-the-job training has been the most popular method since 2005, but the increase in on-the-job training has been visible since 2010. Self-directed learning has led to relatively significant growth in recent years, but not in Czechia. Czech enterprises show the lowest share of using off-the-job methods among all surveyed European countries.

This paper opens a discussion of why Czech companies use less on-the-job methods than other European countries. The trend in the literature or in other countries shows an increasing trend of on-the-job methods and the importance of using this training method. The paper results provide a good starting point for further research and studies related to training and development in organisations. Due to the limitation of data from one survey (Eurostat), the subsequent research work of the authors will focus on other surveys and research papers as well as primary data collection. This paper encourages examining the training methods and their benefits to companies more in detail.

5. Conclusions

The literature review presented in the paper as well as an analysis of data from CVTS confirmed the importance of training and development of employees in organisations. Systematic and continuous vocational training influences the performance of employees and overall organisations. Data from Europe show that the enterprises training is an important issue and they are willing to invest systematically into the development of their employees. Continuous vocational training influences the performance of employees and overall organisations, while different approaches in selected individual countries and time development are required. This paper brings new insight to the problematic of on-the-job and off-the-job training and brings new research questions to the topic of human capital investment. Organisations use both on-the-job and off-the-job methods of training, and it is visible that the intensity differs among countries, and the Czech Republic is not an exception. Although the data are limited to findings from one survey, the paper brings an interesting time comparison and gives space for further and deeper analysis of the topic in the international context.

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Conflict of interest: none.

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Project and Risk Management in the Context of IT Projects

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Abstract: Currently, project management is penetrating to all fields including information technologies (IT). Its implementation as well as impact varies correspondingly to many factors. These include the experience and expertise of the managers as well as companies, type of business, type of project domain, extent of the project (from the perspective of financial, human, technical and other resources) and many more. Similar importance is recognizable in the field of risk management. It represents critical topic relevant for all domains no matter the sector, type and size of business, etc. This area is discussed intensively. Nevertheless, it is still omitted from various perspectives. The insufficient attention to the interconnection of two areas – project and risk management – in various types of projects still occurs. This could result in the serious impact on the project itself as well as on all stakeholders.

Keywords: organizational processes; project management; risk management

JEL Classification: D23; M10; M15

1. Introduction

Realization of every project is a unique change within the organization which creates defined products and brings various forms of benefits. Each project also inevitably carries certain amount of risks and these can be (at least to large extent if the project management is done properly) identified and their probability of occurrence and/or impact can be reduced. Therefore, the efficient risk management strategy should be always included in the project management which is also pre-requirement described in basically every mainstream project management methodology currently.

This paper is focused on the issues of risk definition and types of risks in the context of project management, with more attention towards the projects related to IT field. The authors address (or rather point out) some interesting aspects of risk management which occurred during the literature review, related namely to topics such as discussion about prevention vs response, process design and product planning, and design flexibility within the project when delivering the products.

The paper is structured as follows. The second section deals with the topic of risk and risk management in more general perspective. The third section describes the process of risk identification and possible strategies how to approach it. The fourth section discusses some interesting open issues arising when dealing with risks in broader context, which are often omitted from the methodological point of view.

2. Risk Management in Projects

There are multiple sources of risks that can have impact on the project. The purpose of risk management strategy is to identify them, mitigate the impact or reduce the probability of risk event occurrence. The PRojects IN Controlled Environments (PRINCE2) methodology proposes several ways how to approach the risks, as indicated in Figure 1.

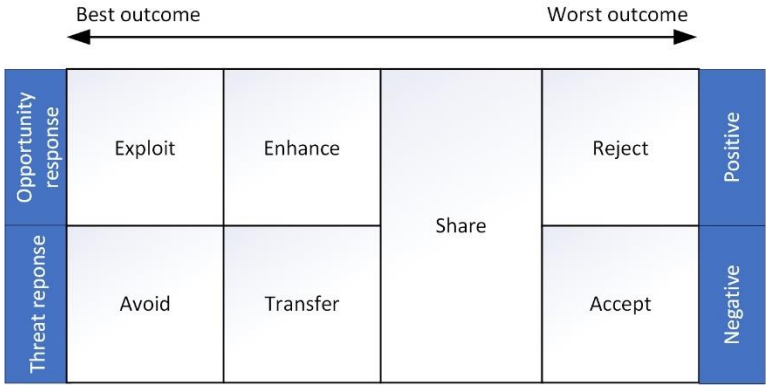

Figure 1. Responses to risks. Own elaboration based on PRINCE2 methodology (Bennett & AXELOS Limited, 2017)

These responses (see Figure 1) are reflected later in the strategic approaches focused on how to deal with the risks, as they are described by Bannerman (2008). These are discussed in more detail in section 3. When considering the importance of particular risk, a matrix representing possible impact and probability (Figure 2) is often used. Bannerman (2008) also provides more formal specification of such matrix as: "*R = P x I where R is the risk exposure attributable to a particular risk factor, P is the probability the undesirable event will be realized and I is the impact or magnitude of the loss if the event occurs.*"

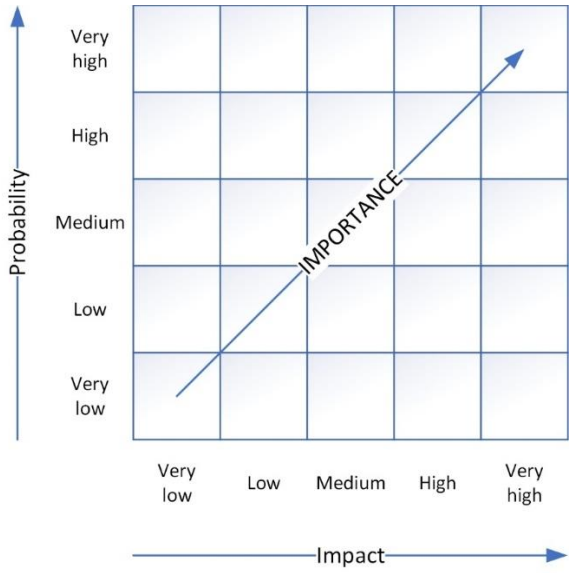

Figure 2. Matrix representing probability and impact. Own elaboration based on PRINCE2 methodology (Bennett & AXELOS Limited, 2017)

The risk exposure in case of a risk event is usually measured in money or time, especially in commercial projects. In this context, it is important to accentuate that risks should be identified before the risk event occurs. It is the matter of proper risk management strategy to identify as many risks as possible, and the process of risk identification lasts during the whole realization of the project.

In the past, risk management was significantly underestimated. For a long time, risk management was done ad-hoc (Fairley, 1990), without systematic thinking and analysis (Chapman, 1997). The authors intentionally use older resources at this point to stress the longevity of the systematic risk management problem. Even decade later, Kwak (2004) states: *"In many organizations, the tendency to 'shoot the messenger' often discourages people from bringing imminent problems to the attention of management. This attitude is the result of a misunderstanding of risk management… most software developers and project managers perceive risk management processes and activities as extra work and expense. Risk management processes are the first thing to be removed from the project activities when the project schedule slips."* Although Kwak`s study is focused primarily on the software development, it is to be expected that situation was similar in other types of projects as well.

Modern approach is more systematic and risk management is in most cases even integral part of the project documentation and monitoring in general. Especially when funded by public sources – most project calls require risk analysis to be a part of project proposal and risks are considered since the beginning. Monitoring reports also often include section for description of risk-related information. This development may be perceived as thoroughly positive.

3. Risk Identification

Risk itself is defined as the 'the exposure to loss/gain, or the probability of occurrence of loss/gain multiplied by its respective magnitude' (Jaafari, 2001). Within the project management, various situations might happen. Theas endanger the fulfilment of the project objectives. Usually, there is the difference between the plans and the reality. During the course of action, some projects might struggle with time delays, human resources, technical issues, particular unexpected situations, etc. These can be either internal or external. Some specific risks are exemplified in the following list (Jaafari, 2001):

- promotion,
- market related to the sales and price setting,
- political connected with many aspects such as legislation, taxes, pollical regime, geopolitical situation, etc.,
- technical including not only technical standards, but also cybersecurity, etc.,
- financing and cost estimate,
- environmental considering the environmental impact of the project,
- organisational addressing the processes and their flow, etc.

No matter the type of risk, all require significant attention and proper treatment.

If the problem of risk identification arises, it is worth notice that some of them are (i) independent on the project domain of expertise, others are on the contrary (ii) derived specifically from the context of the area of expertise, social environment, organizational environment, etc., and third category is derived from (iii) personal context. While the first category is usually related to occurrences of more general issues which any project may face, such as personal changes or data/document loss, other risks are usually quite specific for the project domain. The third category is related to various personality features, experience, and soft skills in general of the people involved in the project, and especially the project manager him/herself. Factors in the third category, potentially severely influencing the way how the risks are approached, are often completely omitted from the methodologies of the project management such as PRINCE2 (Bennett & AXELOS Limited, 2017). Nevertheless, others such as International Project Management Association (IPMA) standard, are taking these aspects into consideration.

Every project and every process consider the critical assets and the connected threats. There are more attributes and aspects to be followed and continually monitored. These include the so-called CIA Triad represented by the Confidentiality, Integrity, and Availability. Moreover, there are issues connected with the value of the assets and the extent of General Data Protection Regulation (GDPR) relevant for the particular asset. The project inputs like data, processes, technologies, humans, etc. are not usually assessed from the perspective of the abovementioned attributes.

Usually, within the project management context, it is important to consider the threats/risks as well as their importance. Any project and domain area should both consider and reflect the risks. There are various approaches addressing the risk identification as well as its treatment during the project. The appropriateness as well as relevance of the theoretical, methodological, practical, and organizational knowledge and skills are very important for the successful and efficient project management. Furthermore, these risks can include the cybersecurity ones which only rise in importance with pervasive nature of digital technologies and data storing technologies.

No matter the methodology of the project management (waterfall, agile, lean, Scrum, Kanban, etc.) or project management standards (PRINCE2, IPMA, Project Management Institute (PMI) - Project Management Book of Knowledge (PMBoK), etc.), the importance and impact of risks pertains. The level of the risk might be added too. Simple table including these details might be prepared. Nevertheless, there are more structured ways how to manage and illustrate these details. For example, within the PRINCE2 methodology, the matrix – including the probability and impact of the risk – is employed (for the simplified version see Figure 2). The risk should be analyzed as well as assessed. Then, the calculations follow. From the project management perspective, there is the need to analyze the risks both quantitatively and qualitatively. Without the respect to the type of risk analysis, the risks should be tackled properly. Therefore, the risk management plan is recommendable. Accordingly, the risks should be omitted/mitigated through the employment of the appropriate measures.

After the risk identification and assessment, the response strategy should be defined. The overall approach connected with the systematic risk management remains more or less

similar to the approaches implemented in the past (Fairley, 1989). The past as well as current authors and methodologies agree on the phases of the risk management process including these steps (Fairley, 1989):

1. Risk identification
2. Impact analysis
3. Contingency planning
4. Risk monitoring
5. Recovery management
6. Crisis management

Again, we used the older reference to (Fairley, 1990) here to show that basics are basically the same. Modern approaches such as PRINCE2 (Bennett & AXELOS Limited, 2017) or PMBoK (Project Management Institute, 2021).

The risk identification which should be project specific. Then, the impact analysis follows. This phase is discussed further above (within this section). There are more potential methodologies of how to assess and consider the possible effects of the identified risks, see practical examples in (Rodney et al., 2015; Rodrigues-da-Silva & Crispim, 2014; Shrivastava & Rathod, 2017). Afterwards, the contingency planning meaning the planning of the response to the risk planning represents the next step followed by the risk monitoring. As described by Rodney (2015), this can be extended to agile approaches as well. The monitoring identifies the risk factors and enables the consequent work on the contingency plan which represents the basis for the recovery management. The final step is the crisis management including the emergency response to the identified risk. These steps might be slightly modified. However, the basic principles remain the same. All these processes should result in the acceptable solution with as small impact as possible.

Bannerman (2008) describes particular risk response strategies differing in the approach to the circumstances, costs, threat or required resources for its solution. He identifies three basic objectives: limitation of the risk impact, reduction or elimination of the threat occurrence likelihood or the combination of the aforementioned.

Bannerman (2008) concludes four core strategies (freely adopted from Figure 1):

1. Avoidance - this strategy focuses on the prevention of the negative effects. It tries to eliminate the circumstances under which the risk occurs. It can also result in the redesign of the project in pursuit to omit the potential arise of the unwanted situation.

2. Transference - this strategy aims to pass the responsibility for a risk to the third party which should address it appropriately. This party should be more experienced in risk management. Nevertheless, the threat for the project is not considered properly and it is under control of the third party.

3. Mitigation - this action reduces the likelihood of the risk occurrence and consequently its impact even before it is revealed or identified.

4. Acceptance - this strategy concludes two potential approaches, passive or active one. The passive acceptance of the arisen situation represents the first option. This is suitable in case of small external risk impossible to be controlled. The contingency plans are usually

available within this strategy. These should include the calculations derived from the matrix above together with the availability of the extra funds or reserves and the guidance what to do in any case.

The appropriateness of these strategies is nevertheless dependent on the abovementioned aspects such as personal traits and experience of the involved people, the organizational processes including their interdependencies and structure, the current context, the availability of the resources, etc. Therefore, all mentioned approaches should be confronted with the current conditions and amended during the course of action.

The overall aim of the paper is to introduce the risks within the project management and the strategies how to manage them. All projects relating to all domains and all sectors face the threats of the risks which might endanger the fulfillment of the objectives. This can result in the particular delays together with the lack of the resources needed for the risk elimination or mitigation. The discussed strategies are limited varietally too and therefore, it is critical to consider reflect many factors which are project specific.

4. Open Issues

The modern era propagates internationalization of the projects and their teams. While the project consortiums are more difficult to be managed in general, increasing in difficulty with rising number of participating entities, cultural issues create specific subset of risks themselves (Liu et al., 2015). To highlight this problem, interesting study made by Shimizu (2014) describes differences in how risk events are being handled by project managers. The study compares situation within Korean and Japanese companies. It concludes that while Japanese approach is more focused on prevention, Korean is more focused on response to risks. The latter seems to be to some extent contradictory to various methodologies, such as perhaps the most frequently used PRINCE2. This expects risks to be identified beforehand and measures to be taken before they can occur. Only consequently, when such event happens, the impact is minimized but by previously prepared actions described in project management strategy. On the other hand, if the project is managed in more agile manner, many risks are more difficult to be identified since the work progress is more vague and product development is incremental. In any case, intensive project planning may be among the most important success factors in projects (Vujović et al., 2020).

The project planning is also closely related to the to the problem of process design and product planning. In order to handle projects of larger scale (and financial magnitude), certain level of organization maturity must be reached. This is even more important when distributed projects are considered (Shrivastava & Rathod, 2017). Process design is closely related to the security issues because process-oriented analysis (with use of tools such as BPMN (Business Process Model and Notation) shows clearly how the work with data objects and artefacts is done and who is the owner of such processes. Internal processes should be prepared for handling the risks. Product planning should – on the other hand - allow certain level of flexibility in reasonable extent. Decision making can be eased by utilization of decision support tools (Fang & Marle, 2012) or use of knowledge-based approaches (Alhawari et al., 2012).

As mentioned above, the certain level of flexibility in design is important to manage risks efficiently. Possibly surprisingly, even in quite rigorous and strict domain such as major infrastructural projects, the flexibility has its place. Study made by Gil (2011) describes case of London Heathrow airport`s expansion. Strong co-operation between the developer and the customer plays important role there and promotes investments in design flexibility. Gil (2011) states that the risk management practices prevail when co-operation breaks down.

5. Conclusions

The basic management rules regarding handling project risks are built upon decades old principles. However, with growing internationalization of projects, IT-related threats, and more consideration to flexibility of the project realization, as well as other modern-day phenomena, various interesting topics arise as well, which were not originally addressed in depth. It is obvious that efficient risk management begins as soon as the project is being prepared, namely with activities such as process design and product planning. Also, the risk management strategy is a living document, meaning it is updated continuously as the project progress forward.

As has been discussed, mainly in section 4, even more rigorous (waterfall) project methodologies might allow certain level of design flexibility when handling dynamic world development influencing the project. Such flexibility might prove to be very useful for risk management effort. This also gives some traction to the trend of making standard project management methodologies slightly more “agile”. Another trend can be seen in more attention being given to personal (mental) attitude towards handling the risks. It is to be expected that there is a logical trade-off between the prevention of the risk and response to it. In the past, risk management was one of the areas which was neglected among the first things when project was delayed or in problems. It may be seen as positive that it is being given more weight nowadays. Hopefully, the future work will be more focused on risk management issues within both project management methodologies and daily practice itself.

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Analysis of the Impact of Selected Macroeconomic Aggregates on the Happiness Index in the Countries of the Czech Republic, Slovakia, Poland and Hungary

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Abstract: The aim of this article is to analyze the impact of GDP per capita and total consumption on the happiness index in the countries Czech Republic, Slovakia, Poland and Hungary for the time period 2012-2020. The happiness index is a UN tool that assesses the happiness and satisfaction of people in each country using its own methodology and then creates a ranking of the happiest countries in the world. The countries analyzed in this article are considered happy in terms of the Happiness Index and hold this position steadily. The analysis is performed using a fixed effects method that works with panel data. The results of the analysis show that only GDP per capita has an effect on the happiness index and total consumption does not have a direct effect on the happiness index. These results are consistent with the findings of other authors who have addressed this issue.

Keywords: happiness; GDP; consumption; panel data; fixed effects

JEL Classification: O1; O4; R11

1. Introduction

Most economic theories agree that money will make people happier. Following this argument, it can be argued that if a person wants to improve their overall satisfaction with their life, the easiest thing they can do to do so is to make more money. If this statement holds true for an individual, it will most likely hold true for a group of people, and hence a nation. That happiness is a fundamental value for a happy life is agreed upon by most researchers who study this topic. The authors Oswald et al. (2015) further add that the happier a person is, the more he or she is able to think critically and also becomes more resilient in solving various problems.

A variety of definitions can be found in the literature. For example, Cherry (2020) defines happiness as "an emotional state characterized by feelings of joy, satisfaction, contentment, and fulfillment". Paul (2015) describes happiness as a certain stable state in which people feel joy. Paul (2015) also adds that there is a difference between happiness and pleasure. He explains this difference on the duration of each state. While happiness, as written above, is a permanent state, pleasure, on the other hand, is a temporary state that can only last for a certain moment. In general, then, happiness can be said to persist for a longer time than pleasure, which is short-lived. Khoddam (2015) defines a happy person as someone who experiences

positive emotions such as joy, interest and pride frequently and negative emotions such as sadness, anxiety and anger less frequently. After examining these definitions, it can be concluded that happiness greatly affects our lives as persons.

Happiness, despite the fact that it is a rather subjective feeling, can be measured using the aforementioned happiness index. It has been published annually by the UN Sustainable Development Solutions Network since 2012, when the first World Happiness Report was published. The Happiness Index is based on the Cantril ladder survey, a questionnaire that represents an imaginary ladder. Thus, respondents answer based on how they would rate their life on a scale from 0 (worst) to 10 (best) (UN, 2020). The factors that influence the respondents' life satisfaction were selected based on research in each area. The main idea of this index is to assess the situation in the countries in question by using the respondents themselves to answer subjectively whether they are satisfied or dissatisfied with their lives. These surveys then result in a ranking of the countries with the happiest citizens.

In the annual report (World Happiness Report, 2021) published by the United Nations, the results of the questionnaire are then compared with the main indicators of certain sectors. These indicators are:

- Gross domestic product per capita,
- Social support,
- Healthy life expectancy,
- Freedom to make life choices,
- Generosity,
- Corruption.

It is with these happiness index results that this article will work further. The main objective of this paper is to find out whether there is a relationship between the happiness index measured in the V4 (Visegrad four) countries between 2012 and 2020, namely the Czech Republic, Slovakia, Poland and Hungary, and selected macroeconomic indicators (total consumption and GDP) of these countries between 2012 and 2020, and then to compare the results with other expert studies dealing with this or similar topics. The existence of a relationship will be verified using the statistical method of panel regression, which will be conducted in Gretl.

2. Literature Review

The topic of the happiness index and its relationship with economics has been addressed by a variety of authors. The research question of whether an increase in the income of all residents will also increase the happiness of all residents was posed by Easterlin (1994) in his study. His findings show that people with more money are indeed happier, but if the income of all residents were increased, it would have no effect on their happiness. Easterlin (1994) explains this conclusion by saying that if everyone's income was increased equally, residents would not have a comparison in how much richer or poorer they are, hence they would have no reason to be happier. The topic of economic growth, happiness and their interrelationship

were addressed by Kenny (1999) in his study. In his study, he measured happiness in selected countries using a self-developed questionnaire. He then compared the results of this questionnaire with GNP per capita and the Gini coefficient, which is used to measure wealth inequality in a society. Using this comparison, he found that there is a relationship between economic growth and happiness but adds that human happiness is a more complex indicator than economic growth and acknowledges that with small variations the result can vary considerably. Another author who has examined the relationship between happiness and the economy is Guven (2008). In his study, he examined whether happiness influences consumer economic behaviour. For his research, he collected data using a questionnaire that consisted of 6 different areas. Using descriptive statistics and then regression analysis, he concluded that there is indeed a relationship between happiness and consumer economic behavior. According to Guven (2008), happy people spend more on life insurance and usually own valuable assets or securities. At the same time, it turns out that happy people are much more risk averse and therefore prefer less risky investments. In contrast, research has shown that happy people save more because of fears about the future. Another study dealing with happiness and various economic variables is by Guo and Hu in 2011. Their regression analysis results show that there is an inverse relationship between happiness, unemployment and inflation. One of the more recent studies that addresses the relationship between happiness and economic growth is a 2018 study by Esmail and Shili (2018). In their study, they try to find and prove the relationship between the overall happiness of the population, which they divided into several groups, in Jazan region and the overall economic growth, which they represented as GDP per capita. Then they determined their hypotheses using a questionnaire that was distributed in Jazan region. The evaluation of the questionnaire showed that there is indeed a relationship between happiness and economic growth. Then social factors (health care, education, unemployment, ...) and economic growth had the strongest positive correlation with each other. Thus, the interpretation of the results says that the higher the health care, education or lower unemployment, the higher the economic growth.

3. Data and Methodology

Guven (2008), Guo and Hu (2011), and Esmail and Shili (2018) all investigated the relationships between variables using regression analysis, so the question arises whether the relationships will be similar if the more current panel regression method is used. Using panel regression, the panel data will be analyzed and then the effect of selected macroeconomic indicators on the happiness index will be determined. Based on annual data from 2012 to 2020, the impact of aggregate consumption and GDP per capita on the happiness index in selected countries (Czech Republic, Slovakia, Hungary and Poland) will be investigated. The statistical analysis will be performed in Gretl.

3.1. Data

Three variables enter the analysis: happiness index score as the dependent variable and total consumption and gross domestic product per capita as independent variables (Table 1).

Table 1. Description of variables used in the analysis

Variable abbreviation	Description of variable
IH_CZ	Happiness index score of the Czech Republic
IH_SK	Happiness index score of Slovakia
IH_HU	Happiness index score of Hungary
IH_PL	Happiness index score of Poland
C_CZ	Total consumption of the Czech Republic
C_SK	Total consumption of Slovakia
C_HU	Total consumption of Hungary
C_PL	Total consumption of Poland
GDP_CZ	GDP per capita of the Czech Republic
GDP_SK	GDP per capita of Slovakia
GDP_HU	GDP per capita of Hungary
GDP_PL	GDP per capita of Poland

Happiness index scores in selected countries (in this case the V4 countries – Czech Republic, Slovakia, Hungary, Poland) were taken from the World Happiness Report (World Happiness Report, 2020), published annually by the UN Sustainable Development Solutions Network. From the data taken, it can be observed that the Czech Republic holds the highest score for the whole period under review. It has held steadily its position among the 25 happiest countries in the world every year. The second happiest country among the V4 countries is Slovakia, followed by Poland and the least happy country is Hungary. See Table 2 for more details.

Table 2. Happiness Index scores in the V4 countries for the period 2012–2020 (Eurostat, 2022)

Year	Czech Republic	Slovakia	Hungary	Poland
2012	6.334	5.911	4.683	5.876
2013	6.698	5.937	4.914	5.746
2014	6.484	6.139	5.181	5.750
2015	6.608	6.162	5.344	6.007
2016	6.736	5.993	5.449	6.162
2017	6.790	6.366	6.065	6.201
2018	7.034	6.235	5.936	6.111
2019	6.911	6.243	6.000	6.242
2020	6.897	6.519	6.038	6.139

The values in Table 3 were taken from Eurostat, the statistical office of Europe. This is the total consumption in the selected countries for the period 2012 to 2020. Consumption includes all spending by the population in a given year. It goes without saying that the more inhabitants a country has, the higher the total consumption of that country (Campbell & Mankiw, 1989). From the data presented in Table 3, it can be seen that consumption increases over the years in all states. The largest drop, which is the same for all states, can be seen in 2020, when the COVID-19 virus pandemic began and with it triggered lockdowns around the world.

Table 1. Total consumption in V4 countries for the period 2012–2020 (EUR million) (Eurostat, 2020a)

Year	Czech Republic	Slovakia	Hungary	Poland
2012	82,888.5	40,732.7	54,954.0	236,522.8
2013	81,327.0	40,801.3	54,296.3	237,822.4
2014	78,188.7	41,472.3	54,497.9	244,489.5
2015	81,921.3	42,627.7	56,617.9	250,827.6
2016	86,007.1	44,320.6	59,490.8	248,805.3
2017	93,972.1	46,995.7	64,636.2	272,543.3
2018	101,734.2	50,056.7	67,966.9	288,413.6
2019	107,225.2	52,766.0	73,395.3	304,275.1
2020	97,578.2	52,607.5	66,950.1	293,898.1

As Table 4 shows, all the V4 countries have an upward trend in GDP, despite the fact that these economies were struggling with the global financial crisis at the time (Table 3). In 2013 and 2014, the Czech Republic suffered a downturn, which was caused by a reduction in external demand. Since 2015, all V4 economies have shown GDP growth above the EU28 average.

Table 4. GDP per capita in V4 countries 2012–2020 in EUR (Eurostat, 2020b)

Year	Czech Republic	Slovakia	Hungary	Poland
2012	15,470	13,570	10,070	10,110
2013	15,170	13,710	10,190	10,340
2014	15,000	14,040	10,630	10,770
2015	16,080	14,730	11,190	11,460
2016	16,790	14,920	11,110	11,850
2017	18,330	15,530	12,170	12,980
2018	19,850	16,420	12,960	13,920
2019	21,140	17,250	13,900	14,950
2020	20,120	16,860	13,650	14,010

3.2. Applied Methods

Panel data analysis was chosen to determine the relationship between the variables. First, the data must be correctly divided into so-called panels. Then a panel regression can be created and constructed. The dependent variable in this model is consumption and gross domestic product (GDP) and the independent variable is the happiness index (life ladder). In this case, the panel regression explains whether there is an impact of macroeconomic indicators on the happiness index in the observed countries (Czech Republic, Slovakia, Poland and Hungary). The panel is constructed from data on an annual basis for all V4 countries.

As mentioned above, the analysis works with panel data, so it is therefore necessary to apply the appropriate methodology. Panel data arise when observations of a given group of units are repeated and the group has some common characteristic (in this case, the V4 countries). The panel data must first be organized in a so-called data cube, which has three dimensions: units, measurements (so-called panel waves) and variables. Units are individuals, firms or, as in this study, countries. If each unit is observed *T* times as the previous one, such

a panel can be called balanced. If there are missing data, for example the number of measurements differs across units, it is an unbalanced panel (Golsch et al., 2013). An unbalanced panel can arise when a data point is missing in a particular year or when a particular unit chooses not to respond. In the case of this study, it is a balanced panel.

The general data structure of a panel regression can be written using a matrix such as:

$$y_i = \begin{bmatrix} y_{i1} \\ y_{i2} \\ \vdots \\ y_{iT} \end{bmatrix} \quad X_i = \begin{bmatrix} X_{i1}^1 & X_{i1}^2 & \dots & X_{i1}^k \\ X_{i2}^1 & X_{i2}^2 & \dots & X_{i2}^k \\ \vdots & \vdots & & \vdots \\ X_{iT}^1 & X_{iT}^2 & \dots & X_{iT}^k \end{bmatrix} \quad \varepsilon_i = \begin{bmatrix} \varepsilon_{i1} \\ \varepsilon_{i2} \\ \vdots \\ \varepsilon_{iT} \end{bmatrix} \tag{1}$$

In general, a regression model for panel data, where the index *i = 1, ..., N* denotes the cross-sectional component and the index *t 1, ..., T* denotes the time component, is defined:

$$y_{it} = x_{it}^{'}\beta + z_i^{'}\alpha + \varepsilon_{it} \tag{2}$$

where

Y_{it} is the explained variable *i* - of that cross-sectional unit in time *t*,

X_{it} is the matrix *K* of the repressors of the *i-th* cross-sectional unit in time *t*,

β is the matrix of estimated structural coefficients of the *i-th* unit over time *t*

Z_i is a matrix containing individual and group variables that are observed (e.g., advice, gender, etc.) or unobserved effects that are constant over time *t*,

α indicates the vector of estimated individual effect structure coefficients,

εit denotes the random component of the *i-th* unit over time *t*.

A panel regression model can be characterized as a modelling approach that incorporates features of both time series analysis and regression analysis (Wooldridge, 2011). Thus, it can be used to evaluate multiple data. At the same time, however, it can also be applied to the treatment of short time series, which also occurred in the case of this analysis. This is because short time series do not allow for a high-quality individual approach, which would generally be considered best. Regression models working with panel data can be divided into three categories - fixed effects regression model, random effects regression model and mixed pooled model. The goodness of fit of the correct model can be determined using the F-test of pooled significance and the Hausmann test, the hypotheses of which are:

- F-test for pooled significance of different means – Hypothesis: pooled OLS is more appropriate than fixed effects method.
- Hausman test – Hypothesis: the random effects model is consistent and more appropriate than the fixed effects alternative (Wooldridge, 2011).

If the *p* value comes out less than 0.05 the given hypothesis is rejected, and an alternative hypothesis should be accepted.

The reliability of the model used is assessed using an *R* value that should be as close to 1 as possible.

4. Empirical Results

Data analysis consists of several steps that are interrelated and interdependent. The first step is to construct the data into a panel, which means that the data is grouped into a three-dimensional data cube that contains input variables such as GDP per capita, total consumption and happiness index score. These variables are then further analyzed using statistical tests. The first is the F-test of pooled significance and the second is the Hausman test, which are used to determine the optimal model to be used to determine the effect of macroeconomic aggregates on the happiness index. This analysis could serve for understanding the relationships between the variables and for identifying measures that could lead to improvements in the standard of living and happiness of the population.

4.1. Analysis of the Impact of GDP Per Capita and Total Consumption on the Happiness Index

The first test conducted is the F-test of pooled significance, which verifies the correctness of the method, in this case the Ordinary Least Squares (OLS) method. The test was performed in the Gretl program, and the result showed a p-value of less than 0.05, which means that the null hypothesis H_0 – the OLS method is adequate should be rejected and the alternative hypothesis H_1 – the OLS method is not adequate should be accepted. Having established this result, we can proceed by conducting a Hausman test to compare the adequacy of different models and to determine the most appropriate model for the panel data.

The Hausman test is a statistical test used to compare the adequacy of different models and to determine the most appropriate model for the data. This test is most often used to compare the random effects method with the fixed effects method, which are two ways we can examine the effect of one variable on the change in another variable within panel data. The p-value after conducting Hausman test came out to be less than 0.05, so the null hypothesis H_0 – The random effects method is consistent must be rejected, and the alternative hypothesis H_1 – The random effects method is not consistent must be accepted.

Table 2. Results of the first step of the analysis (F-test of pooled significance and Hausman test)

Dependent variable: LifeLadder	*p*-value	Result	Interpretation of the observed results
F-test of pooled significance	0.00643976	H_0 rejected	the OLS method is not adequate
Hausman test	0.000244581	H_0 rejected	The random effects method is not consistent

Table 5 shows the results from running the two tests that need to be performed to determine the optimal model to work with later in the analysis. The results show that the optimal model for finding the relationship between the variables is the fixed effects method, since the result of the F-test was necessary to reject the use of the OLS method and the result of the Hausman test was necessary to reject the use of the random effects method. Thus, this part of the analysis shows that the fixed effects method is the optimal model for finding the effect of macroeconomic aggregates on the happiness index.

4.2. Discussion of the Results

The aim of the paper was to investigate the impact of GDP per capita and total consumption on the happiness index in the V4 countries. For this purpose, we used the fixed effects model in Gretl. Our results (Table 6) show that GDP turned out to be a significant regressor, which means that it has a statistically significant effect on the happiness index. This is confirmed by the low p-value, which is less than 0.05. However, the results also show that a 1% change in GDP causes only a negligible change in the happiness index. On the other hand, the effect of total consumption on the happiness index is found to be insignificant, which is confirmed by a p-value greater than 0.05.

These results are consistent with research conducted by other authors, such as Guven (2008), who found that happier people spend more on life insurance but less on luxury goods and services, and Kenny (1999), who found a relationship between economic growth and people's happiness. However, both authors also point out that the results can vary considerably depending on the regions selected.

It should also be mentioned that the reliability of the model used was high, with a predictive power of 87%. This means that the model reflects well the actual relationship between the selected variables.

Table 3. Results of the fixed effects model

Fixed effects model		
Dependent variable: LifeLadder	Coefficient	*p*-value
Regressor		
Consumption	−0.00000374509	0.341
GDP per capita	0.000161005	0.0000193
R-squared	0.874452	

5. Conclusion

The aim of this paper was to investigate the influence of certain macroeconomic variables on the happiness index in the V4 countries (the Czech Republic, Slovakia, Hungary, and Poland). The happiness index is a measure of well-being that is published annually by the United Nations. For this study, two macroeconomic variables were chosen: GDP per capita and total consumption.

The findings of the analysis indicated that only GDP per capita had a significant impact on the happiness index, while total consumption was not significant. These results are consistent with those found in previous studies by Guven (2008) and Kenny (1999).

The Czech Republic, Slovakia, Hungary, and Poland are not only geographically, but also demographically similar, which raises the question of how the relationship between macroeconomic variables and well-being might differ in countries that are less similar. It would be interesting to investigate whether the findings from this study can be generalized to other countries with different demographic and economic characteristics.

Future research could explore the relationship between macroeconomic variables and well-being in a broader range of countries, in order to understand how these factors may vary

across different regions and societies. This could provide valuable insights into the factors that contribute to well-being, and how different policy interventions might impact well-being in different contexts.

This research contributes to the understanding of the relationship between well-being and macroeconomic variables, and further research will be needed to explore this topic in more detail, not just in the V4 countries, but also in other regions around the world.

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Multicriteria Evaluation of Municipal Management Using TOPSIS Technique: Case Study on Slovak Republic

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Abstract: Effective management of (non)public funds is an area for every economic entity that is subject to more and more control. Currently, municipalities in the Slovak Republic are evaluated by law on the basis of a single criterion. This criterion is indebtedness. The aim of the presented article is to offer an alternative in the form of TOPSIS technique and further statistical processing for a comprehensive evaluation of the management of municipalities in the Slovak Republic. Individual mathematical-statistical methods are applied to the basic set of municipalities of the Slovak Republic of 2,940 municipalities with the purpose of identifying, using 8 indicators, the municipality with the best management. One of the results of the performed analyzes is pointing out the differences resulting from different approaches to determining the importance of the evaluated criteria.

Keywords: TOPSIS technique; municipality; Slovakia, weight of criterion

JEL Classification: B23; E69; H11

1. Introduction

The economic activity of each economic entity is regulated by legislation that defines the scope of its activities. According to Act no. 460/1992 Coll. (Constitution of the Slovak Republic) "territorial self-government consists of a municipality and a higher territorial unit". The basic unit is the municipality, which is enshrined in the Constitution and defined by Act no. 369/1990 Coll. on municipal establishment. The essence of higher units (Act No. 302/2001 Coll.) can be defined in such a way that the area of its scope is formed by the territory of a larger number of basic units (municipalities).

Under the conditions of the Slovak Republic, the management of municipalities is governed by the Act no. 583/2004 Coll. on Budgetary Rules of Territorial Self-Government, which considers its indebtedness as the only evaluation criterion of the municipal management (§ 19): "The municipality is obliged to introduce a recovery regime if the total amount of its obligations after the maturity date exceeds 15% of the actual current income of the municipality of the previous budget year and if it has not paid any recognized obligation within 60 days from its due date." The recovery regime precedes the introduction of forced administration and represents a loss of freedom over the administration of the municipality's own finances. At the same time, the law (§ 17) adds that the municipality can accept repayable sources of financing (i.e. credit, loan) to fulfill its tasks only if:

- „the total amount of the debt of the municipality or higher territorial unit does not exceed 60% of the actual current income of the previous budget year and
- the amount of annual installments of repayable sources of financing, including the payment of revenues, will not exceed 25% of the actual current income of the previous fiscal year.“

In the Slovak Republic, there is no framework (including legislation) that would evaluate the complex management and efficiency of municipal management. We consider its absence to be the main research problem of the submitted manuscript. This absence of a municipal management evaluation system formed the starting point for establishing the goal of the presented research, which is to apply verified a multi-criteria decision-making method (Technique for Order of Preference by Similarity to Ideal Solution) to the management of municipalities in individual regions of the Slovak Republic using 8 selected economic criteria.

2. Methodology

A total of 8 criteria were identified for the evaluation of the management of municipalities in the framework of the previous already published research. The identification of individual criteria was based on personal consultations with government auditors of the Financial Control Administration and representatives of municipalities. Their goal was to jointly identify a group of basic criteria that best reflects the real state of management of a specific municipality and that would offer an alternative to the currently valid assessment according to the law. In the first phase, a group of 28 criteria was presented to them, which after several meetings and discussions was minimized to the following group of monitored criteria:

- R1 –total expenditure per capita,
- R2 – share of liabilities in total assets of municipality,
- R3 – total income per inhabitant,
- R4 – profit per inhabitant,
- R5 – return on assets,
- R6 – current expenditures per capita,
- R7 – liabilities per capita,
- R8 – current income per capita.

In our opinion, the given set of criteria meets the requirements set for such a set by Fotr, Dědina, and Hrůzová (2000), i.e. completeness, operability, non-redundancy and minimal scope.

The importance of individual criteria is determined differently, while in the first case the MW (Mean Weight) method is used, which considers all criteria to be equal. In the second case, the weights are determined by an expert sample of 25 experts, which identified the weights of the criteria for ranking the municipalities as follows.

Table 1. Criteria weights assigned by the MW method and the expert group

	R1	R2	R3	R4	R5	R6	R7	R8
MW	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
experts	0.161	0.113	0.150	0.123	0.090	0.144	0.106	0.113

The monitored criteria can be obtained directly from individual municipalities, while the Ministry of Finance of the Slovak Republic also has this data.

The presented research works with a research sample consisting of 2,940 municipalities in the Slovak Republic in 2012, which represents a complete basic set of all municipalities in the Slovak Republic, i.e. research sample no. 2 (Bratislava, Košice were divided into urban districts).

TOPSIS is one of the basic methods of multicriteria decision-making and its primary use is in solving different types of decision-making problems. According to Zavadskas et al. (2016), this method is one of the most widely used, with the AHP, ANP or PROMETHE as possible alternatives. An overview of its applications captures e.g. Tramarico et al. (2015), Ilbahar et al. (2019), who noted an annual increasing number of researches/articles in which the use of not only the TOPSIS technique could be found. The choice of the TOPSIS method for the purposes of our research was based on its previous successful use in solving decision-making problems of a similar nature. Its applications can be found in environmental studies (Rozenthal & Blumberga, 2019; Suharevska & Blumberga, 2019, Siksnelyte et al., 2019), transport (Djordjević & Krmac, 2019), local government (Vavrek & Bečica, 2022), culture (Bečica et al., 2021) and many other areas (see Chang et al., 2010, Behzadian et al., 2012; Luan et al., 2019; Ma et al., 2019; Wu et al., 2019).

The obtained results are subsequently evaluated using a wide range of mathematical and statistical methods including Kendall's rank correlation coefficient, Simple regression model, Levene test, Mann-Whitney test, Kruskal-Wallis test and Dunn test.

All analyzes are processed in MS Office Excel, Statistica and Statgraphics.

3. Results

Individual regions of the Slovak Republic are evaluated as separate analyzes using the TOPSIS technique and criteria mentioned in the previous chapter. This part examines the connection of the achieved result with the size of the statistical unit and individual criteria, the influence of the weights of these monitored indicators and also the geographical classification (into the district or region) on the results.

In the following part, we also deal with the comparison and identification of changes resulting from the change of the compared set (comparison of municipalities in the region versus comparison in the Slovak Republic).

Table 2 captures the correlation between the results in the case of the same and modified weights and individual monitored criteria. The change in weights had no effect on the majority group of pairs (BSK, TSK, TTSK, SR without changes). However, in the case of their occurrence, it was mainly a question of strengthening the correlation. The only correlation confirmed at the level of significance $\alpha = 0.01$ in all regions and the entire republic is the correlation between the result of the TOPSIS technique and criteria R4 and R5, which include the result of management. The difference can be observed especially when comparing the Slovak Republic with individual regions. The intensity in Slovakia confirmed the regional correlations (e.g. R2), or it reduced them. The correlation matrix confirms a statistically significant correlation between the result of the TOPSIS technique and, above all, criteria R2, R4, R5 and R7.

Table 2. Correlation matrix of TOPSIS technique results x criterion

		R1	R2	R3	R4	R5	R6	R7	R8
BSK	E	+M**	-T	+S**	+V**	+V**	+M*	-T	-M**
	M	+M**	-T	+S**	+V**	+V**	+M*	-T	-M**
BBSK	E	-M**	-S**	-T*	+V**	+V**	-M**	-S**	-T**
	M	-M**	-S**	-M**	+V**	+V**	-M**	-S**	-M**
KSK	E	+M**	-M**	+M**	+V**	+V**	+T**	-M**	+M**
	M	+T**	-M**	+M**	+V**	+V**	+T*	-M**	+M**
NSK	E	-M**	-V**	-M**	+S**	+S**	-M**	-V**	-M**
	M	-S**	-V**	-M**	+S**	+S**	-M**	-V**	-M**
PSK	E	-M**	-S**	-T**	+S**	+V**	-M**	-S**	-T**
	M	-M**	-S**	-M**	+S**	+S**	-M**	-S**	-M**
TTSK	E	-S**	-V**	-M**	+S**	+S**	-M**	-V**	-M**
	M	-S**	-V**	-M**	+S**	+S**	-M**	-V**	-M**
ZSK	E	-T	-S**	-T	+V**	+V**	-T	-S**	-T
	M	-T**	-S**	-T	+V**	+V**	-T**	-S**	-T*
SR	E	-T**	-S**	-T*	+V**	+V**	-M**	-M**	-M**
	M	-M**	-S**	-M**	+V**	+V**	-M**	-M**	-M**

Note: BSK - Bratislava self-governing region; BBSK - Banská Bystrica self-governing region; NSK - Nitra self-governing region; KSK - Košice self-governing region; PSK - Prešov self-governing region; TSK - Trenčín self-governing region; TTSK - Trnava self-governing region; ZSK - Žilina self-governing region; SR - Slovak republic

Note: E - equal weights defined based on the MW methods; M - modified weights defined based on the expert group.

Note: $|T| \in <0;0.1)$. $|M| \in <0.1;0.3)$. $|S| \in <0.3;0.5)$. $|V| \in <0.5;1>$

* $\alpha = 0.05$ ** $\alpha = 0.01$

All five assumptions of the regression analysis were fulfilled in the Banská Bystrica self-governing region, the Prešov self-governing region and the Slovak Republic, within which the match of the regression coefficients was also confirmed.

Table 3. Comparison of regression functions

NUTS 3	same weight (MW methods)	modified weights (experts)
BBSK	$V_E = 0.0839367*\ln(PO)$	$V_M = 0.0852169*\ln(PO)$.
PSK	$V_E = 0.082366*\ln(PO)$	$V_M = 0.08281456*\ln(PO)$
SR	$V_E = 0.0881731*\ln(PO)$	$V_M = 0.0871478*\ln(PO)$

Note: BBSK - Banská Bystrica self-governing region; PSK - Prešov self-governing region; SR - Slovak republic.

Based on the partial results processed in the BSK, BBSK, PSK and SR, we confirm the proven dependence of the results on the size of the statistical unit. In the other regions, the first assumption of normality of the residuals was not fulfilled.

Levene's test confirmed the homoscedasticity of the results in all districts of the Slovak Republic. The Mann-Whitney test in 36.11% of the districts also identified the influence of the change in weights on the result (Figure 1). The changes were manifested primarily in BSK, TSK and PSK.

From the point of view of the difference between districts, the differences were confirmed in 6 out of 8 regions of the SR. Dunn's test (Figure 2) subsequently identified districts in these regions that differed from the others.

Within PSK, NSK and TTSK, the test identified pairs of districts that were statistically significantly different from each other. In the Trenčín self-governing region, the reason for the rejection of the null hypothesis of the Kruskall-Wallis test and the subsequently identified

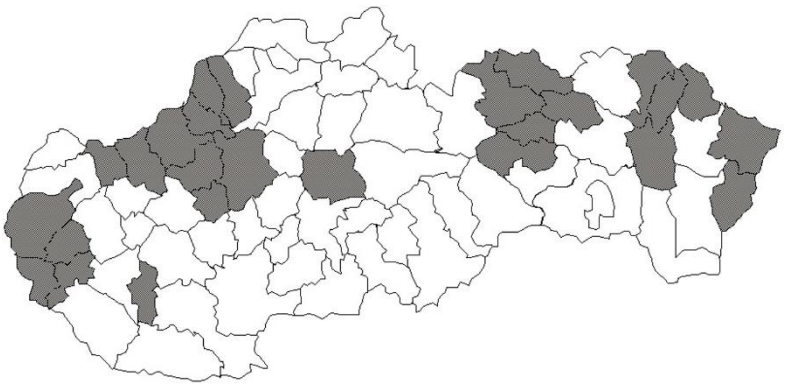

Figure 1. Impact of the change in weights in the districts

Figure 2. Districts identified by Dunn's test

Dunn's test was the district of Bánovce nad Bebravou. In the Banská Bystrica self-governing region it was the Krupina district, in the Košice self-governing region the districts of Košice and Sobrance. The Bratislava self-governing region and the Žilina self-governing region were evaluated as homogeneous at the district level in terms of the achieved results.

Based on the Kruskall-Wallis and Dunn tests, we consider the structure of the regions in the SR to be heterogeneous (differences were identified between all regions, with the exception of the pair BSK - TSK).

Significant differences in the change of the research sample can be observed above all when comparing the range of variation and the results of the TOPSIS application. Figure 3 shows the best average rating of municipalities in BSK (in separate assessment in the regions, i.e., left part of figure 3). Outliers occurred primarily in the Košice self-governing region. By combining and evaluating municipalities in one file (SR - right part of figure 3), however, these differences are eliminated, when the median and average between regions are equalized.

A similar trend can be observed in the case of modified weights. The change of the monitored unit caused overlapping of municipalities and equalization of evaluations. Compared to the results with the same weights, we can observe only minimal differences.

The last part of the comparison is the identification of the change in order caused by the merger of the municipalities into a single unit (Figure 3 and Figure 4). Table 4, respectively Table 5, captures the ranking of the municipalities in the Slovak Republic that ranked first in their region. It is clear from both tables that the municipalities from the Prešov self-governing

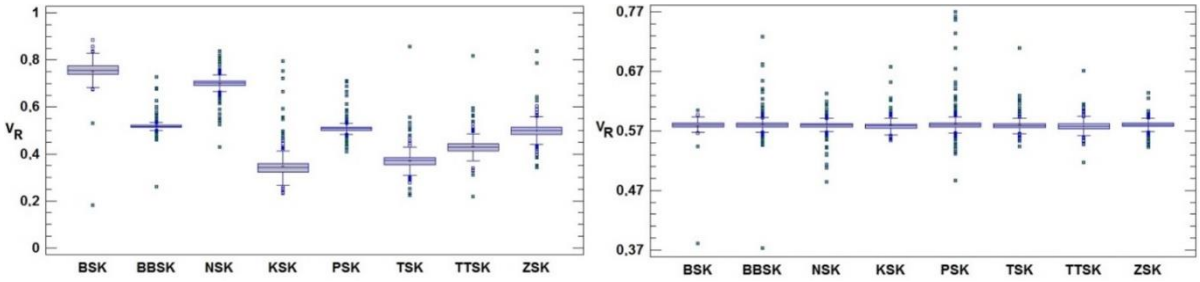

Figure 3. Comparison of the variation range of regions (equal weights based on the MW method); Note 1: BSK - Bratislava self-governing region; BBSK - Banská Bystrica self-governing region; NSK - Nitra self-governing region; KSK - Košice self-governing region; PSK - Prešov self-governing region; TSK - Trenčín self-governing region; TTSK - Trnava self-governing region; ZSK - Žilina self-governing region; Note 2: left side - separate evaluation in the regions; right side - joint evaluation in the Slovak republic.

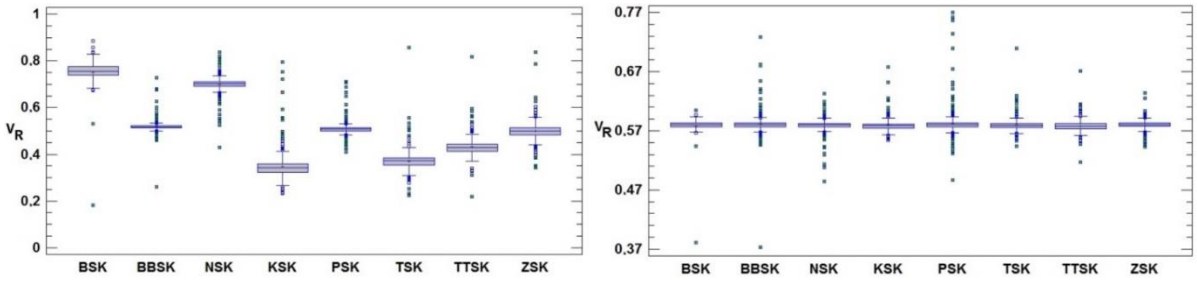

Figure 4. Comparison of the variation range of regions (modified weights based on the expert group); Note 1: BSK - Bratislava self-governing region; BBSK - Banská Bystrica self-governing region; NSK - Nitra self-governing region; KSK - Košice self-governing region; PSK - Prešov self-governing region; TSK - Trenčín self-governing region; TTSK - Trnava self-governing region; ZSK - Žilina self-governing region; Note 2: left side - separate evaluation in the regions; right side - joint evaluation in the Slovak republic.

region were rated the best in the whole of Slovakia. On the contrary, the largest negative impact was the merger of municipalities in the Bratislava self-governing region, whose municipalities from the top ten fell significantly.

Table 4. Comparison of achieved rank (equal weights based on the MW methods)

		ranking in the Slovak Republic							
		BSK	BBSK	KSK	NSK	PSK	TSK	TTSK	ZSK
ranking in the region	1	69	5	22	10	1	6	12	21
	2	116	9	38	14	2	23	42	28
	3	200	8	37	29	3	25	47	26
	4	151	13	40	36	4	33	55	78
	5	144	18	43	32	7	41	57	101
	6	172	20	45	35	11	39	79	107
	7	367	19	48	52	15	56	85	110
	8	192	31	64	63	16	59	88	109
	9	585	44	70	53	17	84	114	162
	10	318	49	90	60	24	115	199	211
average		1,392.76	1,377.83	1,436.97	1,654.55	1,348.79	1,535.52	1,703.49	1,375.33

Note: BSK - Bratislava self-governing region; BBSK - Banská Bystrica self-governing region; NSK - Nitra self-governing region; KSK - Košice self-governing region; PSK - Prešov self-governing region; TSK - Trenčín self-governing region; TTSK - Trnava self-governing region; ZSK - Žilina self-governing region.

Table 5. Comparison of achieved rank (modified weights based on the expert group)

		ranking in the Slovak Republic							
		BSK	BBSK	KSK	NSK	PSK	TSK	TTSK	ZSK
ranking in the region	1	63	5	27	11	1	7	8	20
	2	122	10	38	14	2	31	25	33
	3	117	9	42	21	3	24	39	32
	4	189	16	43	29	4	26	45	70
	5	154	15	47	30	6	36	54	99
	6	280	18	48	40	12	80	66	111
	7	146	19	49	46	13	59	81	89
	8	171	34	68	57	17	64	77	110
	9	643	41	78	73	23	61	105	141
	10	307	53	83	65	28	84	101	172
average		1,392.76	1,387.81	1,380.68	1,427.97	1,648.69	1,367.01	1,523.5	1,693.45

Note: BSK - Bratislava self-governing region; BBSK - Banská Bystrica self-governing region; NSK - Nitra self-governing region; KSK - Košice self-governing region; PSK - Prešov self-governing region; TSK - Trenčín self-governing region; TTSK - Trnava self-governing region; ZSK - Žilina self-governing region.

Despite the success of individual PSK municipalities, the average ranking of municipalities from this region is not that significant. A minimum difference of 5 places can be observed especially after modifying the weights of the monitored criteria.

In 6 out of 8 regions, by modifying the weights of the criteria, their average ranking within the Slovak Republic improved. Its increase occurred only in the Banská Bystrica self-governing region and the Prešov self-governing region.

4. Discussion and Conclusions

Currently, under the conditions of the Slovak Republic, municipalities are evaluated by law only on the basis of a single criterion, which is indebtedness. The presented article offers a summary of own research in the form of an alternative assessment of municipalities using the TOPSIS technique in combination with selected mathematical and statistical methods. Also on the basis of the above TOPSIS, we consider the technique to be a suitable tool for multi-criteria evaluation, for the application of which, however, it is necessary to have suitable criteria (which may limit its use in some cases). Its use is also conditional on their appropriate selection and, above all, determining their importance, which significantly determine the overall results.

At the same time, we consider the conducted research as a starting point that can serve for further qualitative research or as a basis for the management of municipalities. A suitable extension is the analysis of a longer period of time, allowing to follow the development and trend of the obtained results or the application of other methods of multicriteria analysis. We also consider repeating the same research after 10-year period and comparing the results achieved.

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Conflict of interest: none

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B2B Services and Their Impact on Sustainable Development – Case Study

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Abstract: In the last 30 years, the pressure to sustainable development in an educated society has been increasing. Manufacturers face the challenge of manufacturing more products of a higher quality while using fewer resources, polluting the planet less with emissions and waste. However, it is clear that a strategy of sustainability is no longer enough, as the damage already done is so extensive that it is not possible to be satisfied with the current situation and maintain the status quo. Regenerative Development takes sustainability to the next level and provides a framework for incorporating regenerative design principles into the current business processes. The aim of this paper is to identify, analyze and highlight possible ways to transform traditional business models through the services provided into more sustainable, or even into regenerative ones. A case study from a chemical holding company is used. It turned out that this holding, due to its size and especially its strong research base, is transforming towards more sustainable business models, and processes and services leading to regenerative business models are in the research and development phase. It sees more effective results in the combination of servitization with the circular economy and digitalization.

Keywords: sustainable development, regenerative development; services; servitization; manufacturing companies

JEL Classification: O14, L10; Q01

1. Introduction

The impacts of unsustainable human activity affect not only present but in particular future generations. Due to this fact, there has been increasing pressure over the last 30 years to promote sustainable development in educated society. The public is taking an ever more intense interest in climate change and the impact of its behavior (Han et al., 2020). The public also often adopts a negative attitude towards manufacturing companies, and in particular the chemical industry, with regard to their impact on the environment. The chemical industry is the second largest industry in the Czech Republic and is also a key producer for other non-chemical manufacturers. Manufacturers therefore face the challenge of manufacturing more products of a higher quality while using fewer resources, polluting the planet less with emissions and producing less waste (Hami et al., 2015). Key sustainability objectives include social development, economic growth, and environmental protection for future generations (Jelinkova et al., 2021; Lee et al., 2021). Implementation of these objectives is ensured by

engaging in various complex global socio-ecological challenges such as climate change, loss of biodiversity and depletion of all the resources in the world (Opazo-Basáez et al., 2018). In the chemical industry, this concerns use of efficient, effective, safe and environmentally friendly processes and chemical products. The aim is to use the necessary resources efficiently to meet the needs of customers and therefore to reduce wasteful use of essential resources by using efficient production methods or by substituting substances which are less demanding in terms of their subsequent disposal (OECD, 2022).

However, it is now clear that a strategy of sustainability is no longer enough, as the damage which has already been done is so extensive that it is not possible to simply settle for the current situation which we find ourselves in and to maintain the status quo (Gabel, 2015). The negative impacts of unaddressed challenges would further exacerbate and even accelerate slow but, for the time being, irreversible destructive processes, which is why we now need a regenerative approach to addressing environmental, social, economic, and cultural challenges (Nemethy, 2021). Regenerative Development and Design takes sustainability to the next level and provides a framework for incorporating regenerative design principles into your current process (Regenesis Group, 2016).

Businesses are therefore looking for ways to transform their traditional business models into not only more sustainable ones but ideally regenerative models. Manufacturers adopting responsibility for the entire life cycle of products/chemicals, i.e., from their efficient use, all the way through to environmentally friendly treatment or reuse of waste, could represent an important step towards this. The adoption of a business strategy, for which the term "servitisation" has been coined, could contribute significantly towards increasing this accountability (Vlckova et al., 2021). The development of a service-based economy may be the way out of this situation in our consumer society which is unsustainable over the long term (Bellos & Ferguson, 2017).

Therefore, we formulated a research hypothesis: providing B2B (Business-to-business) services with significant support of own research and development is one of the paths to Sustainable even to Regenerative Development. To verify this hypothesis, the following aims were set: to identify, analyze and highlight possible ways to transform traditional business models, not only to become more sustainable, but also to become regenerative. Use is made of a case study from the chemical holding BASF. The holding includes a Czech subsidiary which engages in sales on the Czech, Slovak and Hungarian B2B markets. With a turnover of € 78.6 billion in 2021, the company is the largest chemical producer in the world. It has manufacturing facilities on every continent in more than 90 countries. It is a major employer and employs around 10,000 people in research and development. The holding was granted 820 patents in 2021 (BASF report, 2021). Given its size and strong research base, it can also be expected that this company will be a leader in the ongoing transformation of chemical companies towards more sustainable and regenerative business models.

A partial aim of this paper was to conduct a targeted literature search focused on possible paths towards more sustainable processes in the chemical industry, particularly through the B2B services provided i.e., services offered by manufacturing companies on the industrial market. This transition of manufacturing companies from selling products to selling product-

service systems (PSS) is also referred to as servitization. On the basis of these results, the objective was then to identify opportunities for businesses to contribute towards achieving sustainable or even regenerative development through their offer of services on the industrial market. The results should help direct manufacturing companies in the Czech Republic towards making greater efforts in transformation of their business model towards servitisation as a strategy to support not only sustainable development but also as a path to regenerative development.

2. Methodology

Primary and secondary sources were used to verified the formulated hypothesis and to address the objectives. Secondary sources used were mainly foreign scientific articles and studies. The Web of Science was used as a source for finding thematically focused professional articles. During the search, the following keywords were entered: servitization, services, product service system, PSS, B2B services, sustainability, sustainable development, B2B, manufacturing companies and various combinations of their chains, with a time limit between 2010–2022. The official BASF website were also used as a source of information, where, among other things, reports for 2020 and 2021 are published (BASF, 2020), (BASF, 2021). These set out the overall corporate strategy, the results in the three main areas of sustainability with more precise specification for each area of business, the sustainability targets for the coming years and the processes used to achieve them.

The results of in-depth interviews conducted using interview scenarios prepared by us were used as the primary source. These were aimed at identifying and analyzing the services provided and demanded in the industrial market and their influence on sustainable development. Interviews were conducted with the Technical Sales Manager in the Performance Materials Division and the Marketing Manager in the Agricultural Solutions Division and took place from January to April 2022. From a total of 11 BASF business divisions, these two divisions were chosen because they have an independent sales office in the Czech Republic and, above all, they offer interesting services to their customers with an impact on sustainability and, especially in the Agricultural Solutions Division, on regenerative development.

The outputs of the article were elaborated on the basis of content analysis, comparison and synthesis of information obtained from the primary and secondary sources.

3. Results

3.1. Possible Paths to Sustainability in the Chemical Industry

The current strategy for sustainable development has generally evolved from efforts to change the poor condition of the environment, gradually all the way to prevention of this situation (Vezolli et al., 2014), e.g., by changing the materials used, the technology, the amount of energy and understanding customer requirements etc. Current trends towards sustainable development applicable to the chemical industry include the circular economy, principles of Green Chemistry as well as application of a business strategy of servitisation

(Han et al., 2020). These directions can be mutually complementary, enabling manufacturers to achieve sustainability in all three areas (Parida & Wincent, 2019). The success rate in implementing these strategies is very closely related to the use of appropriate project management methods and tools (Kostalova & Tetrevova, 2018; 2014).

In the circular model (3R-Reuse, Recycle, Reduce), the waste generated is reused, recycled or otherwise recovered, thereby reducing consumption of primary material and energy (Korhonen et al., 2018). Materials used in production and energy consumption should in particular be reduced, waste and old used products or their parts should be reused and recycled (Kirchherr et al., 2017).

By applying the concept of Green Chemistry, companies seek to minimize waste, hazardous substances, workplace hazards and inefficiencies in production by designing optimal processes (Linthorst, 2010). This corresponds to Responsible Care, which aims to promote improvement of performance through efficient and effective manufacturing using minimum resources. In 2021, 54 chemical companies in the Czech Republic were entitled to use this logo (https://www.responsiblecare.cz/companies). The contribution of Responsible Care towards sustainability consists in particular in implementation of the so-called European Green Deal.

Applying the servitization strategy means the gradual transition of a manufacturer from offering a product, then adding services to go with products, all the way through to offering the service itself is referred to as PSS (Product Service system) (Baines et al., 2007; Baines et al., 2009; Haase et al., 2017; Yang & Evans, 2019). This comprises a system of products, services, support networks and infrastructure designed to be competitive, meet customer needs and have a lower environmental impact than traditional business models (Mont, 2002). PSS is considered to be the most appropriate business model for the circular economy (Michelini et al., 2017). Customers do not buy ownership of a product, they buy the service of using it (D'Agostin et al., 2020). This for example concerns a customer support service, a risk and reward sharing agreement, or payment for use of a product (Baines & Lightfoot, 2014). Companies in the Czech Republic are particularly trying increase the customer value and thus differentiate their offerings through the services (Vlckova & Podskubkova, 2020). Customers can also be offered an entire solution as the highest level of servitisation, where it is up to the manufacturer how to meet the customer's requirements (Geng et al., 2019). Barquet et al. (2016) described five main factors which lead to sustainability of PSS: application of a design for the environment, identification of economic value for all stakeholders, promotion of a change in behavior among customers and providers, definition of actions for social well-being and innovation on different levels. Typical business models associated with servitisation for the chemical industry are chemical leasing, chemical service management, Take Back Chemicals, outsourcing and conventional leasing.

The strategy of servitisation yields the best economic and environmental results, primarily due to cost reduction and efficient use for manufacturers (Annarelli et al., 2020). The advantage for customers is in particular that they gain the desired result without having to deal with repairs and maintenance, release themselves from any responsibility for operation of the product and achieve lower costs relating to care for the product

(Baines et al., 2007; Baines et al., 2009). Manufacturers remain the owners and operators of the products, allowing them to retain their know-how and improve the technologies which they use to generate revenue (Sakao et al., 2013). A positive legislative factor may be reduction of risk associated with regulation of the business and market environment, given the great flexibility of this business model (Sakao & Lindahl, 2015).

Other possible paths to sustainability in the chemical industry include combination of servitisation with green services or digitalization. The aim of green servitisation is to reduce the environmental impact associated with the manufacturing and use of products by offering green services (Marić & Opazo-Basáez, 2019). Digitalization in itself helps to achieve sustainability and in conjunction with sustainable servitisation forms the modern trend of digital servitisation (Kohtamäki et al., 2019). This concerns an offer of intelligent software services allowing for monitoring, control, optimization and autonomous functions.

3.2. The Essence of Regenerative Development

The problem of sustainability is the absence of a holistic worldview, i.e., the perception of the world as interconnected and mutually interacting systems. However, in practice, systems do interact mutually. This has created the need to view the world holistically, i.e., through the principles of regenerative development. Its first definitions appear in architecture, in the context of the built-up environment, when Reed (2007) and Du Plesis (2012) come up with the idea that the process of building can also bring about positive changes within a system and add value to the unique place in which it is located.

Regenerative development is now understood as achieving positive, broader social, natural, financial and human outcomes through expedient investment decisions (Qadir, 2022). In general, sustainable development strategy has gradually evolved from trying to change the poor condition of the environment to preventing this situation from ever occurring (Vezolli et al., 2014). Sustainable development is about using resources to improve the well-being of society in a way that does not destroy or undermine the support systems needed for future growth. In addition to this, regenerative sustainable development is about using resources to improve the well-being of society in a way which builds the capacity of the support systems needed for future growth (Gabel, 2015).

3.3. Results – Case Study

The Performance Materials Division of BASF's Czech subsidiary sells foam specialties and thermoplastic polyurethanes (TPU) which are used, for example, in shoe soles and roofing membranes. In 2021, the annual sales of the entire BASF holding in this division increased by 29.4% compared to the previous year. The Agricultural Solutions Division sells fungicides, herbicides, insecticides and biological solutions, as well as optimizing and developing desirable seed properties. Here, the year-on-year growth of revenue in 2021 was 6.6% (BASF, 2021).

Sustainability Goals of the Holding

A content analysis of the annual reports from the point of view of their relation to sustainability as presented on the holding's website revealed the following findings.

- The holding is an active member of the Responsible Care initiative. It is focused on innovation of its products and technologies helping to use natural resources more efficiently, produce enough food for everyone, reduce emissions, enable smart mobility without having a negative impact on the climate and improve renewable energy options.
- The strategic objective of the holding is to continue to grow its profitability and make a positive contribution towards society and the environment. To make sustainability a greater force for innovation and achieve higher annual sales by 2025 with Accelerator products (products which meet strictly determined dynamic rules relating to sustainable impacts during manufacturing, use and disposal). This target was already exceeded by almost 10% in 2021.
- The holding measures its contribution towards sustainability via its own Value to Society methodology, which makes it possible to compare economic, environmental and social impacts.
- The holding is a supporter of the UN Sustainable Development Goals and has signed up to the Paris Agreement.
- The long-term goal, based on the Green Deal for Europe or the Paris Agreement, defined for the Czech branch is to ensure zero CO_2 emissions by 2050, e.g. through an intelligent manufacturing system which adds value through the efficient use of resources.
- The short-term sustainability goals are: to use renewable energy, to ensure efficient production and consumption of own energy, to implement sustainable water management, to respect human rights, promote employee diversity and inclusive workplaces, ensure a safe working environment, promote ecosystem protection (e.g. participation in the Waste Elimination Alliance), embrace responsibility throughout the supply chain, improve the supply chain CO_2 management program and to streamline consumption of resources e.g. with the aid of circular economy principles.

Sustainability Objectives of Individual Divisions

The in-depth interviews conducted with selected managers in both divisions were aimed at specifying and, if necessary, supplementing the sustainability objectives stated in the holding's reports and, in particular, at identifying the services offered and their potential impact on sustainable or regenerative development.

In the Performance Materials Division, the specific goal is to ensure that waste is recycled back into the company by 2025 and used in 40 products. Across the entire holding, the goal is generation of € 17 billion in sales of recycled granulate or recycled end products by 2025.

The following services provided to go with products were identified here: recycling of waste plastic products within the framework of the ChemCycling project, transportation to the customer warehouse with the aid of a third party, introduction of new projects to promote sustainability, education through online courses for the public about new TPU materials and their use, expert advice to customers on injection moulding of TPU, operation of an information center for customers on technical issues relating to plastic products, management of a publicly accessible materials database, processing of product information and measures for declaration of performance and certification of management systems,

materials testing, research and development to speed up the customer production cycle, as well as 3D modelling of products.

The following objectives have been set for the Agricultural Solutions Division throughout the holding: promotion of biodiversity, prevention of soil degradation, protection of water, soil and other natural resources, ensuring effective pest control, avoiding wasteful use of plant protection products, reducing CO_2 production in agriculture, increasing knowledge of agriculture among the general public, ensuring profitability for farmers, promoting higher yields and therefore avoiding famine in developing countries, reducing CO_2 production by 30% by 2030, using 7% more modern technologies with higher efficiency and digitalizing 400 million hectares of fields.

The following services provided were identified: arranging transportation with the aid of a third party, buy-back of packaging, optimization of product use and care for fields via mobile apps (for weather forecasts, soil analysis, identification of diseases and pests, as well as optimization of product application), support for the activities of farmers leading towards the correct use of products, advice on biodiversity, cooperation with other companies and research and development e.g. of smart sprayer functions or sprays contributing towards sustainability.

4. Discussion and Conclusions

A targeted literature search showed that businesses are encouraged by the public, their competitors and also by their customers to find ways to contribute towards sustainable development. In the chemical industry, given the nature of the activities performed there, which significantly affect the environment, current approaches to sustainable development include the circular economy, Green Chemistry and, in recent years, also servitisation.

Through the interaction of these trends, and in particular by embracing digitalization, manufacturers can achieve greater sustainability in all three areas. For example, an offer of intelligent software services enables online monitoring, control, optimization and autonomous functions. However, it is now already clear that sustainability development needs to move beyond this, towards utilization of resources to improve the well-being of society in a way that also builds the capacity of the support systems needed for future growth. This means not merely maintaining the status quo but moving towards Regenerative Development and Design. This takes sustainability to the next level and provides a framework for incorporating regenerative design principles into your current process.

Content analysis, comparison and synthesis of the information obtained, particularly in the field of sustainability targets and services provided, showed that all of these trends are implemented to varying degrees at BASF. Our assumption was confirmed that BASF, due to its size and in particular its strong research base, is not only transforming towards more sustainable business models, but that processes and services leading to regenerative business models are already in the research and development phase.

Both divisions provide basic transport services as well as intermediate services such as professional consultancy, which can to a certain extent contribute to sustainable development, especially in the area of the environment. However, it is offers of customized

research and development services which fall under the green servitisation business model that turned out to be ~~are~~ particularly relevant to sustainable development. One example we can give from the Performance Materials Division is their offer of optimization of the properties of TPU granulate according to customer requirements and, in particular, shortening of the production cycle while maintaining the same manufacturing conditions, which reduces the customer's energy consumption per unit of production. In the Agricultural Solutions Division, this concerns research and development to improve the performance of products such as fungicides or to reduce nitrogen losses in manure, or, in cooperation with other companies, development and application of a capping system for filling of spray tanks which prevents exposure on the part of the operator and the spray dripping on the surrounding area, or a smart sprayer which can distinguish weeds from the crop which is being grown and target sprays effectively.

Both divisions offer digital services which enable application of the highest level of servitisation, i.e., the business model of customized integrated solution providers. For example, the Performance Materials Division offers a final product modelling service to determine the optimum material for their customers' specific manufacturing requirements with a positive impact on sustainable development.

The Agricultural Solutions Division provides farmers mobile applications to monitor, control and optimize the application of products or sowing time and harvesting in agricultural fields, including selection of suitable seeds. It also participates in development and research into these. It uses satellite imaging and photographs to do this. These services, aimed at monitoring, diagnosing and optimizing the agricultural cultivation process, provide not only significant support to farmers but also significantly contribute towards sustainable development. A solution-oriented PSS model is also in the trial phase. This should provide comprehensive services to the landowner to ensure not only the desired yield from a given harvest but also future growth through gradual soil regeneration thus also contribute significantly to regenerative development.

If we proceed from the established facts: (i) the servitisation is seen in the holding as a strategy to secure long-term relationships with customers (as it enhances social, economic and environmental sustainability) and (ii) the holding sees more effective results in the combination of servitisation with the circular economy and digitalization and (iii) the holding is focusing in this direction also the necessary research and development of products, processes and technologies, even beyond the framework of its own company and beyond the framework of sustainable development, although it has not yet explicitly mentioned regenerative development in its strategy, than it is possible to make conclusion about the acceptance of the formulated hypothesis, i.e. that providing B2B services with significant support of own research and development is one of the possible paths to Sustainable even to Regenerative Development.

This case study can thus be a suitable example and inspiration for other manufacturing companies in the Czech Republic to contribute to sustainable or even regenerative development through the expanding offer of B2B services. It is also a way to favourably change the often negative attitude of society towards manufacturing companies, especially

in such a sensitive sector as the chemical industry, with regard to its impact on the environment.

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Challenges and Changes in Internal Communication within Organizations: The Role of Transparent Communication from the Top

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Abstract: Internal communication contributes significantly to good internal working relationships by facilitating effective dialogue between management and employees. The paper examines Czech organizations' approach to setting up internal communication from the top, i.e., from senior positions to lower-level employees. The COVID-19 has significantly changed the way of communication; it is necessary to revise the results of research on internal communication from the top. The main objective is to evaluate the relationship between selected identifying variables on the use of different forms of management-to-employee communication. A questionnaire survey of Czech organizations (n_1 = 183) was conducted, and the obtained data were evaluated using selected statistical methods (chi-square test, Fisher's Exact Test, Fisher-Freeman-Halton Exact Test). The results reveal that 16% use only one form of communication from the top, and 17% use two forms. Approximately 69% of the surveyed organizations use a maximum of 4 forms of communication from the top. The dependence of the selected types of communication from the top on the type of organization in terms of majority ownership and size of the organization was found for: electronic communication, communication through a representative, online team communication, and written communication at the 0.05 level of significance.

Keywords: brainstorming; COVID-19; information transparency; interpersonal communication; online meetings; webinar

JEL Classification: M12; M19; D83

1. Introduction

Intra-organizational communication is applied to convey information, cooperate, help each other, clarify ambiguities and avoid contradictions. According to many experts, a functioning internal communication that permeates an organization is both a driving force and a prerequisite for a smooth operation and organizational climate, which might be perceived as the integration of practical and theoretical interrelated disciplines (Castro & Martins, 2010; McMurray & Scott, 2013; Sengupta & Sahay, 2017). Eisele et al. (2013) or Abbah (2014) emphasize the need to establish an effective motivation system, create a sense of security, and an effective communication system. One of the significant strengths of small and family-owned organizations is that everyone knows each other. It is easy for the owner to discuss whatever

he deems appropriate; most employees know each other. The better employees know each other, the more likely they will communicate and work together effectively. However, in large organizations, there can be a trouble as communication with employees is not as straightforward and obvious.

Daily practice shows (Harrison & Bazzy, 2017; Narayana, 2017) that organizational culture has close links with the various HR and social processes within communication and the whole HRM concept. According to Thelen and Formanchuk (2022), ethical organizational culture is crucial in maintaining transparent internal communication.

To our knowledge, no other study exclusively related to communication from the top has been conducted in the Czech Republic. Therefore, the original purpose of the study was to fill a gap and research the approach to communication from the top in Czech organizations, especially in the context of the dynamic changes of the current times. The COVID-19 pandemic has caused several changes in communication practice, as shared by many research studies (Hurst, 2020; Lee et al., 2020; Li et al., 2021; Ruck & Men, 2021; Hitka et al., 2022). The main aim of this paper is to evaluate the dependence of selected identification variables on the use of different forms of management communication toward employees.

The manuscript includes an introduction to the issue, the theoretical background of communication from the top, and its context with information transparency and accountability, followed by the research methodology. The third part consists of the main results of the quantitative research of data from a questionnaire survey within Czech organizations, followed by a discussion and a final summary of the results concerning the formulated main objective.

2. Theoretical Background

The importance of internal communication as a critical area of communication practice continues to grow (Welch, 2012; Men & Bowen, 2016; Stacho et al., 2021; Verčič, 2021; Stacho et al., 2022). Communication from the top directs information messages from higher positions to lower organizational-level workers. Some of the reasons why downward communication is essential for organizational sustainability include:

- A critical variable in determining the success of an organization (Welch, 2012; Men & Bowen, 2016; Ruck & Welch, 2019),
- Coordination of tasks to meet the organization's goals, the key to deployment and performance (Men & Bowen, 2016),
- Providing information about the values, vision, and mission of the organization (Neill, 2016),
- Determines stakeholder perception of the corporate image and status (Men & Bowen, 2016),
- Creating a good employer brand (Verčič, 2021),
- Managing problem-focused control and reducing uncertainty (Lewis & Sahay, 2018; Li et al., 2021),
- Motivation toward sustainability (Hitka et al., 2022; Horbach et al., 2022),
- Cultivating employee creativity (Lee & Kim, 2021),
- Developing positive employee engagement, a sense of belonging, and employee commitment (Bakker et al., 2011; Men & Bowen, 2016; Ewing et al., 2019; Verčič, 2021),

- Enabling the access to relevant information (Verčič, 2021),
- Supporting organizational change (Li et al., 2021),
- Facilitating meaning-making processes and building relationships with quality (Mazzei, 2014).

Transparency is vital in the context of internal communication from the top, as managers should provide all comprehensive information to their employees, whether it is positive or negative news (Li et al., 2021). Li et al. (2021, p. 2) state the importance of participative transparency as "actively participate in information seeking, distribution, and creation with their employees." Participatory transparency is not always compatible with the principles of communication from the top, so it is also appropriate to add information transparency characterized by always providing accurate, comprehensive, and complete information. Li et al. (2021) add "accountable" to the above elements of information transparency. Andersson (2019) introduced the concept of communication accountability, whereby effective communication throughout the organization is the basis for setting the social responsibility of organizations (Martos-Pedrero et al., 2022).

Table 1. Types of communications from the top toward the employees of the organization

Type of communication from the top	Description	Reference
Brainstorming, brainwriting	Brainwriting has several advantages compared to brainstorming (speed, anonymization, the problem of solid individualities, etc.). It is advisable to take advantage of both methods and combine them appropriately.	Gilmartin et al. (2019); Paulus and Kenworthy (2019)
Electronic communication	Email, specifically tailored video messages, HR portal, intranet, internal social media, etc. The pandemic has accelerated the digital transformation of organizations.	Men (2014); Ewing et al., (2019); Li et al. (2021); Mazurchenko et al. (2022)
Communication through employee representatives or the trade union	Employees are guaranteed the right to elect their representatives, trade union organizations, works councils, and health and safety representatives. Workplace representatives ensure that what they learn from management is communicated unchanged.	Djurkovic et al. (2021)
Online meetings, webinars, videoconferences	Utilized because of the different geographical locations of the jobs.	Hurst (2020)
Face-to-face team meetings, discussions	Immediate interaction, feedback, supported by non-verbal communication.	Hargie and Tourish (1993); Lee and Kim (2021)
Written communication directly to employees	Guaranteed preservation of information in its original form, e.g., company magazine, newsletter, brochure, manual, bulletin board, mailbox, bulletin, memo.	Heller and Rowlinson (2020)
Dedicated evaluation and feedback process in SW	It represents a space for self-reflection, impetus for further development, eliminating repetition of the same mistakes, ensuring greater employee well-being, and assisting decision-making processes.	Men and Yue (2019)
Oral communication directly to employees	Immediate interaction, feedback, supported by non-verbal communication.	Hargie and Tourish (1993); Lee and Kim (2021)

Deficiencies in internal communication from the top can lead to mistakes or reduced performance and loss of motivation, increased dissatisfaction, and employee attrition. Communication is often hampered by a complex or overly atomized organizational structure, especially too many management positions. Silla et al. (2017) found that employee satisfaction with communication is partly related to positive relationships between creative culture and a safe work environment. According to Men and Yue (2019), management's supportive communication in an organization induces a positive emotional culture. Moreover, "internal communication plays an active role in shaping and changing the organizational culture" (Men & Yue, 2019, p. 3).

A communication audit (Hargie & Tourish, 1993), which is a regular and systematic analysis of an organization's internal communication in content and tools, can help reveal internal communication flaws. Table 1 shows the types of communication identified above according to articles searched from Scopus and Web of Science from 2012–2022.

The effective use of information and communication technology (ICT) in organizational processes can make these processes more efficient, even without reducing personal communication or hindering employees' creative thinking (Lee & Kim, 2021). For most organizations, it was inevitable to provide greater process flexibility in the wake of the COVID-19 pandemic (Hurst, 2020; Ruck & Men, 2021). Electronic communication, HR portal, or internal social media (Ewing et al., 2019) also allows access to selected data to employees. This method is considered an effective tool for communicating with employees. The types of communication listed above in Table 1 are explored in more detail in the questionnaire survey in selected Czech organizations at the peak of the COVID-19 pandemic.

3. Methodology

850 Czech organizations were contacted from the ALBERTINA database from June 2020 to December 2020. The questionnaire was designed to comply with ethical rules and with the requirement for anonymity. The questionnaire was completed mainly by managers of the organizations or by the owners of small businesses. Quantitative data (n_1 = 183) were obtained by a questionnaire survey in the Google Form; thus, the return rate of the questionnaire was about 22%. A preliminary survey (n_2 = 10) was carried out to see if the questions were understandable.

The primary identification questions of the questionnaire survey include the following variables:

- The business sector of the organization (4.4% fall under the primary sector, 41.5% fall under the secondary, and 54.1% under the tertiary).
- The organization´s size by the number of employees (26.2% fall under the category of fewer than 50 employees, 28.4% under the one with 51–249 employees, and 45.4% fall under the category of more than 250 employees).
- The majority ownership (45.4% with Czech owners and 54.6% with foreign owners);
- the type of the organization (there are 85.8% private, 11.5% public, and 2.7% non-profit organizations).

- The annual turnover (38.3% fall under less than EUR 10 million, 37.7% under EUR 11–50 million, and 24% fall under over EUR 50 million).

According to the formula (1) followed by Bonferroni correction, the chi-square test was applied to verify the dependencies in the contingency tables.

$$\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{s}\frac{(n_{ij} - m_{ij})^2}{m_{ij}}, \quad (1)$$

where:
n_{ij} – observed frequency,
m_{ij} – excepted frequency.

The statistical analysis was employed using the statistical program IBM SPSS Statistics, v. 28, with a significance level equal to 0.05. The results, based on synthesis, induction, and deduction, are presented in the chapter on Results.

4. Results

Respondents were surveyed on which type of the above communication forms they use (multiple responses were possible). Figure 1 shows the frequencies for each form of communication.

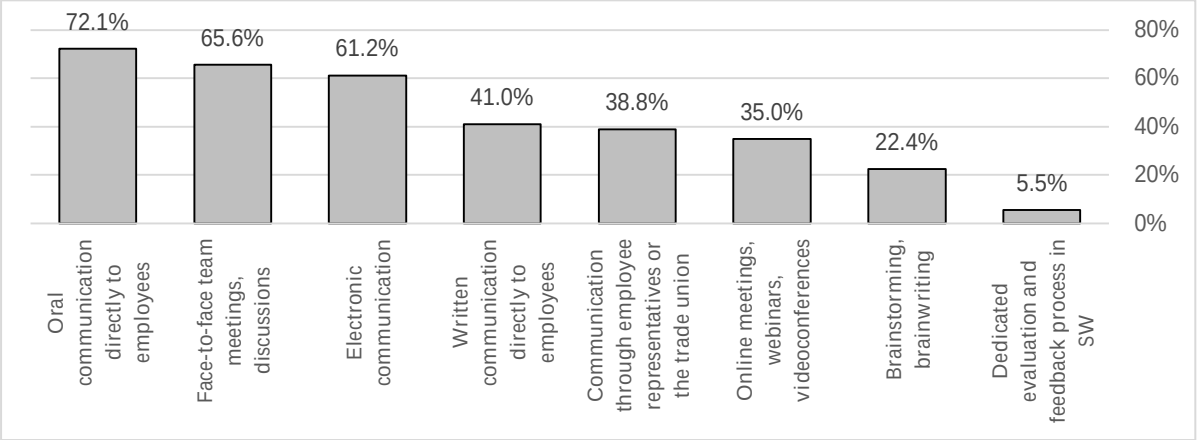

Figure 1. Use of different forms of communication

Each type of communication was assessed depending on the selected identification factors. The following factors were selected as essential: the size of the organization in terms of staff number, the type of organization regarding majority ownership, and the annual turnover.

The relationships between the different types of communication and each identification factor were evaluated using a chi-square test followed by Bonferroni correction. For the two most frequently reported forms of communication, according to Figure 1, i.e., verbal communication directly to employees and face-to-face meetings, no difference was found between organizations according to the above identification factors. However, differences depending on the type of organization were found for the types of communication ranked third to sixth. Table 2 shows the results for the forms of communication whose use varies according to the organization's size.

Table 2. Selected forms of communication from the top depending on the size of the organization

Form of communication from the top	Test	Test criterion	df	*P*-value
Electronic communication	chi-square test	13.171	2	0.001
Communication through employee representatives or the trade union	chi-square test	11.831	2	0.003
Online meetings, webinars, videoconferencing	chi-square test	15.525	2	<0.001
Written communication directly to employees	chi-square test	15.399	2	<0.001

All four types of communication are significantly more frequent in businesses with 250 or more employees. Practically two-thirds of businesses with 250 or more employees (74.7%) use electronic communication, but less than half (43.8%) of businesses with up to 50 employees use it. Less than 17% of companies with fewer than 50 employees apply online meetings compared to almost half of large companies, where online meetings are used.

Table 3 shows the results of tests to assess the use of each form of communication in terms of majority ownership (Czech vs. foreign majority-ownership). Remarkable differences were found in electronic communication, communication through representatives, online team communication, and written communication.

Table 3. Relationship between the type of organization in terms of majority ownership and the use of selected forms of communication from the top

Form of communication from the top	Test criterion	df	*P*-value
Electronic communication	12.924	1	<0.001
Communication through employee representatives or the trade union	13.825	1	<0.001
Online meetings, webinars, videoconferencing	11.789	1	<0.001
Written communication directly to employees	9.146	1	0.002

All four types of communication are more common in foreign ownership companies, as illustrated in Figure 2.

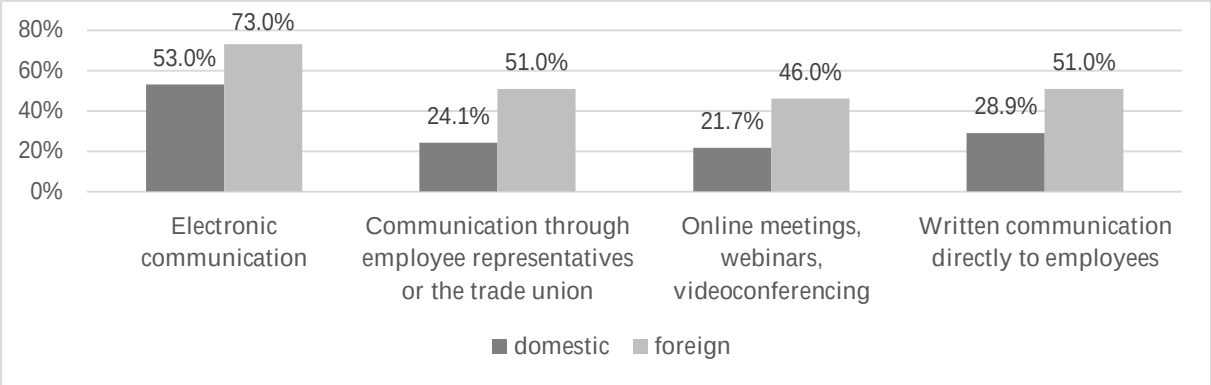

Figure 2. Use of different forms of communication

The last factor considered was the size of the turnover. Table 4 shows the results of the tests to assess the relationship between the selected types of communication from the top and

the organization's annual turnover. A significant relationship was identified in the case of electronic and proxy communication. No relationship was found for the other types of communication. The use of electronic communication and communication through trade unions increases with the level of turnover, which is, however, closely related to the organization's size.

Table 4. Relationship between an organization's annual turnover and the use of selected forms of communication from the top

Type of communication from the top	Test criterion	df	*P*-value
Electronic communication	11.988	2	0.002
Communication through employee representatives or the trade union	11.440	2	0.003

Table 5 below shows enterprises' absolute and relative frequency (including a cumulative relative frequency) by the total number of forms of communication from the top.

Table 5. Transfer of crucial information to employees - number of forms of communication from the top

Communication from the top – number of firms	Frequency	Percent	Cumulative Percent
1	30	16.4	16.4
2	31	16.9	33.3
3	34	18.6	51.9
4	32	17.5	69.4
5	38	20.8	90.2
6	14	7.7	97.8
7	3	1.6	99.5
8	1	0.5	100.0
Total	183	100.0	

Table 5 reveals that 30 organizations (16%) use only one form of communication from the top, 31 organizations (17%) use two forms, and about 52% of the surveyed organizations apply a maximum of 3 forms.

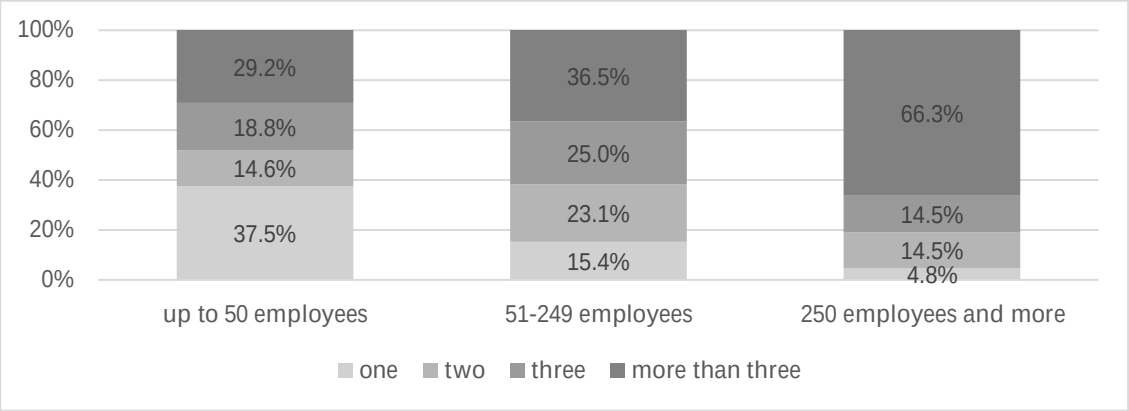

Figure 3. Transfer of crucial information to employees - number of forms of communication from the top depending on the size of the organization

Supposing that we differentiate organizations that use a maximum of three types of communication versus organizations reporting more than three forms, the number of

communication forms is mainly related to the organization's size (p<0.001). Besides, it also differs between domestic and foreign organizations by majority ownership (p<0.0001).

Figure 3 shows that two-thirds (66.3%) of organizations with 250 or more employees use more than three forms of communication from the top, while the proportion for smaller businesses is quite the opposite (29.2% and 36.5%, respectively). Figure 4 shows that there is almost double proportion of foreign organizations using more than three forms of communication from the top compared to domestic organizations.

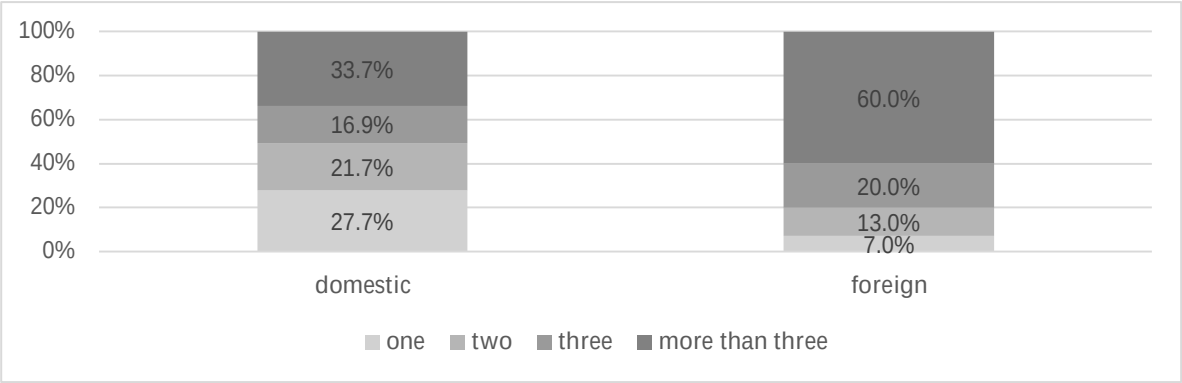

Figure 4. Transfer of crucial information to employees – number of forms of communication from the top depending on the type of organization by majority ownership

Moreover, the authors put focus on combining selected communication forms used together. No organization reported an exclusive combination of two types of communication from the top in the form of electronic communication and a dedicated software evaluation and feedback process. Eight organizations (4%) use electronic communication and specialized software, but always in combination with other types.

Further analysis focused on "oral communication", represented by the following types of communication: face-to-face team meetings, discussions, and oral communication addressed directly to employees. The outcome of the analysis revealed that 92 (50%) organizations apply both face-to-face meetings and oral communication as a form of communication. Seven enterprises out of those mentioned above reported using only these two forms of communication from the top.

5. Discussion

The research shows that an effective combination of communication methods is needed in organizations to achieve transparent communication from the top, increase awareness of all parties during change, and promote a positive organizational climate. The combination of communication methods will help to set up an effective communication system, which follows the research of Abbah (2014). Face-to-face communication (i.e., face-to-face team meetings and discussions) can be provided utilizing online meetings, webinars, or video conferencing; however, the priority of effective information transfer is to have the camera on (specific meeting stream), which also supports the social aspect of communication. Based on the results, the authors recommend that organizations apply an appropriate combination of face-to-face communication supported by electronic communication and feedback elicitation.

This suggestion builds on the research of Men and Yue (2019), who emphasize feedback as a stimulus for further development.

Considering the Covid-19 era and thus forced working from home, internal communication, primarily communication from the top, has taken a new dimension for which most organizations were unprepared. The impossibility of communicating face-to-face during a complex lockdown still forces organizations to search for and set up appropriate communication flows to inform employees, stimulate them and keep them loyal. This fact is in line with the findings of Lie et al. (2021) and Anderson (2019) or in the framework of the necessity of setting up corporate social responsibility, according to Martos-Pedrero et al. (2022). This research and the best practice of organizations show that organizations are still not fully prepared for a situation in which face-to-face communication with employees will not be possible in many sectors. They are constantly optimizing the communication setup from above that will help to effectively share all information and changes and align the eventual performance of duties at high awareness, even when working from home. Immediate feedback, whether in person or electronically, will become increasingly necessary.

Based on the results, the authors suggest that organizations use internal magazines or newsletters, specifically written communications aimed directly at employees. Furthermore, organizations can identify opinion leaders or representatives from individual workplaces, actively engage with them, and transfer information from management to all employees. According to the research, occupational health and safety is becoming, and will continue to become, an integral part of supporting the social responsibility of organizations. A responsible employer must offer a safe working environment and be able to communicate everything to all employees in a timely and transparent manner. By setting the communication right from the top, employees can be encouraged to be more motivated to meet the organization's goals, which is supported by the research of Djurkovic et al. (2021) and Lee and Kim (2021).

According to Wiedmer (2015), organizational leadership needs to lead a multi-generational workforce through effective, transparent communication. This can be achieved by tailoring communication for each generation, creating work opportunities and flexible working conditions, and continuing to support the capabilities of each generation (Urbancová & Vrabcová, 2022), which is supported by the results presented in this paper.

5. Conclusions

This research fills a knowledge gap in investigating the application of selected types of communication from the top within Czech organizations across sectors. The results indicate that 16% of the surveyed organizations implement only one form of communication from the top, and 17% use two forms. Approximately 69% of the surveyed organizations implement no more than four forms of communication from the top.

The most frequently reported forms of communication were oral communication and face-to-face meetings. The authors observed no difference in the frequency of using the forms of communication from the top depending on selected identifying factors such as the size of the enterprise or type of organization in terms of majority ownership. However, differences

were found for the other types of communication listed above in order of frequency of use in the third to sixth position: electronic communication, communication through employee representatives, online team communication, and written communication. Business size and type of organization by majority ownership emerged as critical factors influencing these forms of communication. The frequency increases with the organization's size and is also more common in foreign organizations.

It can also be noted that the chances of using more communication forms rise with the increasing number of employees, just as more communication forms are reported for organizations with foreign majority ownership.

A limitation of the research is that only Czech organizations are involved; future research will focus on countries with a broader range of organizations across the Visegrad Four. The research processed 183 responses, which is representative of strict adherence to all methodological rules. However, respondents may have tended to form a better picture of their organization and to act more rationally. Nevertheless, the questions were asked in a non-judgmental manner while following the rules of social science research.

Conflict of interest: none.

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How Entrepreneurship Incentive Policies Affect Urban Innovation? A Study Based on National Entrepreneurial City Policy

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Abstract: Innovation is the only way to promote sustainable economic growth, and it is also an important way to solve China's regional development and transform the existing urban economic development model. This paper takes the construction of national entrepreneurial cities as a "quasi natural experiment" to study how the pilot policies aimed at encouraging entrepreneurship affect the level of urban innovation. The research finds that the construction of national entrepreneurial cities has significantly improved the level of urban innovation, which is robust. The mechanism shows that the construction of national entrepreneurial cities has effectively reduced the institutional transaction cost, increased the financial expenditure on science and technology, and improved the entrepreneurial activity, thus promoting the innovation level of pilot cities.

Keywords: national entrepreneurial city; urban innovation; institutional costs; entrepreneurship activities

JEL Classification: C51; D78

1. Introduction

With the rapid development of science and technology in the 21st century and the deepening of economic globalization, scientific and technological innovation has become the key to the success of competition between countries. Since the reform and opening up, the Chinese government has attached great importance to the cause of scientific and technological innovation and has done a lot of work. Not only that, the central government has also listed building an innovative country and innovation driven development as a national strategy to promote scientific and technological innovation. In the process of implementing innovation to lead development, the Chinese government has carried out a number of policy pilot work, providing many guarantees from the administrative, legal, financial and basic technology supply aspects. According to statistics, during the "13th Five Year Plan" period, the number of invention patent applications in China ranked first in the world. By the end of 2019, the number of authorized and effective invention patents had reached 2.67 million, ranking second only to the United States, ranking second in the world and becoming a major innovation country.

The factors affecting innovation are complex. Since Schumpeter put forward the theory of "creative destruction", the relationship between entrepreneurial activities and innovation has attracted the attention of many scholars. In Schumpeter's view, entrepreneurial activities

give birth to entrepreneurs, and innovation is an attempt by entrepreneurs to make new combinations in order to bring excess profits in the process of entrepreneurship, so entrepreneurship is the key to innovation (Schumpeter, 1934). Not only that, existing studies believe that start-ups are not only participants in general innovation activities, but also the key source of disruptive innovation (Zhang & Ran, 2019). However, influenced by the social environment and space, entrepreneurial behavior is actually a "regional event" (Feldman, 2001). In order to promote the emergence of entrepreneurial activities, the Chinese government implemented the national pilot policy of entrepreneurial cities in 2009. The existing research on the policy mainly focuses on the entrepreneurial effect of the policy (Zeng & Wen, 2021). Due to the close relationship between innovation and innovation, the incentive for entrepreneurial activities in the implementation of the policy pilot will also be transmitted to innovation activities, but there is no clear answer to the impact of national entrepreneurial cities on innovation. Based on this, this paper attempts to study the impact of national entrepreneurial cities on the level of urban innovation, as well as the possible path of pilot policies on urban innovation.

2. Theoretical Background and Literature Review

2.1. Theoretical Background

Since the reform and opening up, China's economy has taken off at a high speed, precisely because a large number of entrepreneurial activities have sprung up, stimulating the vitality of the market economy (Zhou, 2013). It has been widely believed that entrepreneurship is an important way to promote the employment of residents and stimulate market vitality (Content et al., 2019). To this end, the Chinese government regards the promotion of entrepreneurship as an important part of its public policy and expects to build an ecosystem to support the creation of new enterprises (Bruton et al., 2018). The most famous one is the call for mass entrepreneurship and innovation. In addition, as early as 2009, the Chinese government launched a national entrepreneurial city pilot program to promote urban entrepreneurship, with a view to creating a good business environment to promote entrepreneurship, giving play to the employment multiplier effect of entrepreneurship, and thus promoting the transformation of economic structure.

2.2. Literature Review

Innovation is an activity with uncertain returns and accompanied by high risks (Oliver & Moore, 2008). For incumbent enterprises in the market, such enterprises can obtain normal profits in their business activities under the existing factor endowment. Therefore, they are conservative about innovation activities. For start-ups, only through innovation can they survive in the market and gain market share. As a result, startups tend to be more willing to engage in innovative activities. Not only that, unpredictable and disruptive innovations often occur in start-ups. Mature large companies are good at improving innovation, while disruptive innovation usually comes from newly established companies (Zhang & Ran, 2019). This is mainly because traditional large companies are usually vested interests of the status quo, and

disruptive innovation will destroy the status quo and endanger their vested interests. On the contrary, entrepreneurs take more risks, have more decision-making power, and ultimately can obtain greater returns. Disruptive innovation is unpredictable in nature, and it is impossible to preset an effective incentive system. The best incentive system is profit sharing. In fact, innovators become entrepreneurs.

The innovation activities of the micro market subject occur in a specific regional environment, which cannot be separated from the impact of the existing regional system, resource supply and a series of other aspects. As the main institution and resource supplier in the regional economic and social development (Yang & Zhao, 2020), the government has a profound impact on the regional innovation level. Due to the lack of formal systems, local governments have played a key role in resource allocation, profoundly affecting market structure and innovation activities. In regions with imperfect institutional environment, due to the great spillover effect of innovation and the inherent high-risk attribute of innovation activities, market economy is likely to provide insufficient innovation. At this time, the government's financial expenditure on science and technology is the key to restrict the micro innovation subject to obtain innovation input (Che et al., 2020). In addition, the weak protection of intellectual property rights has made the results produced by micro innovation subjects who spend a lot of money and energy can be captured by other market participants at a cost far lower than the innovation cost, which is a great blow to the innovation power of micro innovation subjects.

The government's public policies form an institutional framework, which in turn determines the costs and trade-offs of entrepreneurial activities (Minniti, 2010). Therefore, in any specific context, government public policies have a great impact on the occurrence of various types of entrepreneurial activities. In order to promote the emergence of entrepreneurial activities, local governments have implemented various entrepreneurial policies such as tax relief, entrepreneurial subsidies, and interest free loans to attract new companies. It is hoped that these start-ups can promote economic growth within their jurisdiction. As an entrepreneurial incentive policy of government departments, national entrepreneurial cities can stimulate entrepreneurs' entrepreneurial enthusiasm by creating a good external environment (Fritsch & Schilder, 2008). At the same time, the government's initiative to guide entrepreneurship can break the monopoly and information barriers in the free market to a certain extent, mobilize the enthusiasm of social entrepreneurship, and thus provide a foundation for innovation activities. In addition, the complicated administrative examination and approval procedures also create a broad space for the incumbent enterprises to safeguard their monopoly interests and engage in non-productive rent-seeking and corruption activities, increasing the cost of potential innovators. The national entrepreneurial cities take optimizing the efficiency of government services, vigorously promoting the reform of streamlining administration and delegating powers, and simplifying the administrative approval procedures as the pilot tasks, with the aim of reducing the market institutional transaction costs, improving the efficiency of resource allocation, and helping to promote innovation activities.

3. Methodology

3.1. Model Building

The construction of national entrepreneurial cities is a pilot policy implemented by the central government to stimulate entrepreneurial activities, which has a strong exogenous impact on innovation activities. This paper regards it as a "quasi natural experiment" and uses the double difference method (DID) to study the impact of national entrepreneurial city construction on urban innovation activities. The research sample selects 282 prefecture level cities from 2006 to 2019, including 77 national entrepreneurial cities.

This paper constructs the virtual variable $treated$ and $time$ of entrepreneurial cities. In order to solve the sample bias problem and endogenous problem, this paper adopts the method of combining the tendency matching score method with the double difference model (PSM-DID) in the robustness test, so as to obtain the policy processing effect. The model settings are as follows:

$$\text{Innovation}_{it} = \alpha_0 + \alpha_1 CY + \alpha_n X_{it} + \sigma + \varepsilon_{it} \quad (1)$$

In formula (1), subscript i represents city and t represents time. $Innovation_{it}$ is the explained variable of this paper, representing the entrepreneurial activities of city i in year t; $CY = treated \times time$ is the core explanatory variable; X_{it} refers to a series of control variables that change over time and affect urban entrepreneurial activities; σ is urban fixed effect and time fixed effect; ε_{it} is the error perturbation term. α_1 is the core parameter of this paper, which represents the impact of entrepreneurial city construction on innovation activities. If entrepreneurial city construction can bring about the growth of urban innovation activities, then the α_1 should be significantly positive.

3.2. Variable Definition and Data Source

Interpreted variable. Most of the existing literatures use the number of patent applications in the same year to measure innovation activities, but there are some defects in this way. This paper selects the urban innovation index released by Kou et al. to measure the comprehensive innovation level of cities at various levels. Since this index is only published to 2016, this paper obtains the urban innovation index after 2016 by interpolation fitting.

Explain variables. The explanatory variable of this paper is the virtual variable (CY) of entrepreneurial city construction. As of the end of 2019, there are 77 cities in China with entrepreneurial city construction. This paper constructs two dummy variables: ① policy shocks $treated$). If a prefecture level city becomes a pilot city for entrepreneurial city construction, the assigned value of $treated$ is 1; otherwise, the assigned value of $treated$ is 0; ② Policy time ($time$). If a city was approved as an entrepreneurial city construction pilot in 2009, the value assigned to it in the current year and later is 1, and the previous value assigned to it is 0, thus the explanatory variable $CY = treated \times time$。

Mediation variables. Based on the above mechanism analysis, this paper selects institutional transaction costs, government financial expenditure and entrepreneurial

activity as intermediary variables to test the impact of entrepreneurial city construction on urban entrepreneurial activities. Among them, (1) institutional transaction cost ($cost$), this paper uses the ratio of the sum of financial expenses, management expenses and sales expenses of listed companies in various cities to the total assets of listed companies in cities to measure institutional transaction costs. (2) Government financial science and technology support (kj), we use the proportion of government science and technology expenditure in public financial expenditure. (3) Entrepreneurial activity (ea), this paper measures the entrepreneurial activity based on the proportion of urban private and individual employees in the total resident population at the end of the year.

Control variables. Drawing on the research of existing scholars on innovation activities (Autio et al., 2014; Nicholas et al., 2019; Yan et al., 2021), this paper also adds a series of control variables to reduce endogenous problems caused by other factors not considered. The details of the control variables are as follows: the wage level of residents ($wage$) is measured by the average wage of urban employees; The degree of opening to the outside world (fdi) is calculated by dividing the amount of foreign direct investment by GDP. Since the amount of foreign direct investment is US dollars, it is converted into RMB at the annual exchange rate published by the People's Bank of China; Infrastructure level (inf) is measured by the ratio of urban road area to area under jurisdiction; Industrial structure ($cyjg$) is measured by the ratio of urban tertiary industry output value to GDP.

Data source. The variables in this empirical study are all from the China Research Data Service Platform (CNRDS) database. For the missing data of some prefecture level cities in some years, the statistical yearbook of the province (district) where the city is located is used to supplement. Descriptive statistical results of each variable are shown in Table 1.

Table 1. Descriptive statistical analysis of variables

Variable	N	Mean Value	Std. Dev.	Min	Max
Innovation	3,934	9.934	41.344	0.000	1,037.31
CY	3,934	0.213	0.409	0.000	1.000
$cost$	3,934	0.065	0.061	0.000	0.495
kj	3,934	0.030	0.021	0.068	20.509
ea	3,934	0.124	1,478.687	0.005	3.092
$wage$	3,934	4.380	2.040	4.958	137.085
fdi	3,934	0.180	0.198	0.00	2.101
inf	3,934	0.275	0.504	0.024	7.527
$cyjg$	3,934	47.238	10.928	11.392	90.971

4. Results

4.1. Basic Inspection

This paper uses OLS and heteroscedastic robust standard to get the estimation result of DID by mistake. The result is shown in column (1) (2) of Table 2, where column (1) is not added with control variable, and column (2) is added with control variable.

Table 2. Impact of National Entrepreneurial City on urban innovation.

Variable	Basic inspection		Robustness check			
	(1)	(2)	(3)	(4)	(5)	(6)
CY	23.074*** (3.02)	16.500*** (3.26)	4.237*** (3.10)	16.460*** (3.25)	7.988*** (3.98)	13.041*** (2.89)
Cons	0.921 (0.53)	-19.186** (-1.98)	4.029*** (32.36)	-19.447** (-1.99)	8.606*** (-2.50)	-18.514** (-1.73)
control variable	/	Yes	Yes	Yes	Yes	Yes
Other policies	/	/	/	/	/	Yes
City fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
N	3,679	3,679	3,341	3,727	3,679	3,679
R2	0.587	0.677	0.631	0.741	0.706	0.640

Note: *, **, *** are significant at the level of 10%, 5% and 1% respectively. In parentheses, there is the value of t.

It can be seen from Table 2 that the pilot policy can significantly improve the urban innovation index of 23.074 pilot cities without adding control variables. Considering that the average value of the innovation index of all cities in the study sample is only 9.934. Therefore, the construction of entrepreneurial cities can effectively promote the innovation activities of pilot cities. When control variables are added, the impact of pilot policies on innovation activities is reduced, but the relative value still reaches 16.5. Therefore, whether or not the control variables are included, the estimated value of the impact of entrepreneurial city construction on innovation activities is significantly positive, indicating that entrepreneurial city construction has significantly improved the level of urban innovation.

4.2. Robustness Check

(1) Replace the interpreted variable. Although the urban innovation index can comprehensively reflect the innovation level of a city, patent applications can more directly reflect innovation activities. This paper uses the number of patent applications in the year (1,000) as the proxy indicator of urban innovation level to re estimate the benchmark model. The results are shown in column (3) of Table 2. It can be seen that the impact of entrepreneurial city construction on proxy indicators of urban innovation activities is still significantly positive.

(2) PSM estimation. The whole research sample of this paper includes most prefecture level cities in China. Due to their own endowment, geographical location, history and culture and many other factors, the comprehensive development of these cities is quite different, and the innovation activities of different cities cannot meet the assumption of consistent time effect. In order to overcome the bias of estimation results caused by possible trend differences between pilot cities and non-pilot cities, this paper adopts the method of combining PSM-DID to solve the sample bias and endogenous problems and obtain the policy treatment effect. The results are shown in column (4) of Table 2. It is not difficult to find that the estimated coefficient of the impact of entrepreneurial city construction on urban innovation activities is positive at the significance level of 1%, which strengthens the conclusion of this paper.

(3) Exclude extreme value effects. In the benchmark regression, there may be interference of extreme values on the regression results. In order to avoid the interference of extreme values on the regression results, this paper shrinks the tail of all variables by 1%, and then regresses again. See column (5) in Table 2 for the regression results. It can be seen from the table that the tail shrinking treatment does not affect the result that the construction of entrepreneurial cities helps to enhance the level of urban innovation, which verifies the hypothesis of this paper.

(4) Control other policies. While building innovative cities, the central government has also implemented other policies to promote innovation, especially city-based pilot policies. Through collection and collation, it is found that national innovative cities have the most direct impact on the level of urban innovation. Therefore, this paper adds the policy impact dummy variable of this policy in the empirical study to control its impact on the level of urban innovation. The results are shown in column (6) of Table 2. It can be found that after controlling the potential impact of innovative city pilots, the estimation coefficient is still significantly positive at the significance level of 1%, indicating that the innovation policy at the city level does not cause bias to the estimation results in this paper.

4.3. Action Path Test

According to the above analysis, the construction of entrepreneurial cities may bring about the growth of urban innovation level through three ways: reducing institutional transaction costs, increasing financial expenditure on science and technology, and improving entrepreneurial activity. Therefore, this paper uses the intermediary effect model to empirically test the above mechanisms.

1. Institutional transaction cost ($cost$). Innovation is a highly complex process of resource allocation, and the existence of institutional transaction costs in the market makes the circulation of factor resources not smooth, which will reduce the willingness of entrepreneurs to engage in innovation. Moreover, the reduction of institutional transaction costs will effectively improve the operational efficiency of the market economy system and stimulate the rise of innovative activities. This paper uses the ratio of the sum of financial expenses, management expenses and sales expenses of listed companies in each city to the total assets of listed companies in cities to measure the institutional transaction costs. The regression results are shown in column (2) (3) of Table 3. It is obvious that the construction of entrepreneurial cities has reduced the institutional transaction costs of pilot cities at a significant level of 5%. It can be seen from column (3) that the impact of institutional transaction costs on urban innovation level is obviously negative. This shows that the construction of entrepreneurial cities can bring about the growth of urban innovation level by reducing institutional transaction costs.

2. Financial expenditure on science and technology (kj). The high risk and long cycle characteristics of innovation make it face strong financing constraints. The government expenditure on science and technology can not only directly provide innovation funds to improve the incidence of innovation, but also the government's support for enterprises' science and technology funds can bring demonstration effects and help enterprises with

subsequent financing. This paper uses the proportion of government science and technology expenditure in public financial expenditure to measure the intensity of financial science and technology expenditure. The regression results are shown in Column (4) (5) of Table 3. The result of column (5) shows that the pilot policy helps to improve the financial science and technology expenditure of government departments, and the financial science and technology expenditure is at a significant level of 5%, promoting the improvement of urban innovation level. Therefore, we can say that the construction of entrepreneurial cities has promoted the improvement of urban innovation level by increasing financial expenditure on science and technology.

Table 3. Function mechanism of National Entrepreneurial City on urban innovation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CY	16.500*** (3.26)	-0.012** (-2.66)	16.253*** (3.15)	3.164** (2.16)	15.665*** (3.32)	0.018** (2.07)	11.460** (2.94)
$cost$			-20.463* (-1.99)				
kj					0.272** (2.38)		
ea							2.059*** (3.98)
control variable	/	Yes	Yes	Yes	Yes	Yes	Yes
City fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3,934	3,934	3,934	3,934	3,927	3,934	3,934
R2	0.677	0.694	0.677	0.580	0.685	0.816	0.760

Note: *, **, *** are significant at the level of 10%, 5% and 1% respectively. In parentheses, there is the value of t.

5. Conclusions and Discussion

How to stimulate innovation is a fascinating issue. There have been studies discussing it from various angles such as intellectual property protection, government grants, fiscal decentralization and so on (Guo & Zhuang, 2017; Guo, 2018; Li et al., 2021). There are also many literatures concerned about the impact of the innovation incentive policies formulated by the government on innovation activities (Li & Yang, 2019; Zhou & Li, 2021), but few studies have considered the innovation effect of non-innovation incentive policies. This paper studies the impact of the pilot policies for the construction of entrepreneurial cities aimed at encouraging entrepreneurship on the level of urban innovation. The research results show that the construction of entrepreneurial cities can effectively improve the innovation level of pilot cities, and the conclusion is still valid after a variety of robustness tests. This shows that because innovation and entrepreneurship are closely related, the government's policies to promote regional entrepreneurial activities can also help promote local innovation activities. Secondly, the impact of the construction of entrepreneurial cities on the innovation level of pilot cities is mainly due to the fact that the pilot cities have effectively reduced the institutional transaction costs, increased the financial expenditure on science and technology,

and improved the entrepreneurial activity during the pilot period, thus promoting the improvement of the innovation level of pilot cities.

Of course, affected by the COVID-19, the author is unable to obtain the latest research data, so the research sample range needs to be updated. Innovation activities have a strong continuity. The level of urban innovation in the previous period will affect the level of urban innovation in the current period, which has not been considered in the research model of this paper. Last, this paper has not yet discussed whether the innovation effect of entrepreneurial city construction is regulated by other factors. China is in a critical period of economic transformation, and innovation driven development has become a national strategy. Therefore, there may be external factors regulating the impact of entrepreneurial city construction on the innovation level of pilot cities, which is also the next research direction of this article. Entrepreneurship is a key driving force for economic development and national growth, and innovation is the only way to ensure that a country can achieve sustainable long-term productivity growth. Studying whether the policies aimed at encouraging entrepreneurship contribute to innovation can help the government better clarify the formulation and implementation of policies, thus promoting the mutual promotion of entrepreneurship and innovation.

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CCUS Development in China and Forecast Its Contribution to Emission Reduction

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Abstract: Nowadays environmental issues have been of great concern to the world, among which the problem of global warming caused by greenhouse gas emissions is particularly prominent. All countries in the Kyoto Protocol and the Paris Agreement have committed to control greenhouse gas emissions, and China, as the largest carbon emitter, has assumed a heavier burden. China has been striving to develop low-carbon technologies such as hydrogen, nuclear, wind, and solar energy, but the most attention should be paid to CCUS, which many scholars have high expectations that CCUS can help China reduce emissions to some extent. Therefore, this paper presents a prediction that CCUS can reduce 3.8% of carbon emissions for China in 2040 when CCUS emission reductions increase at a rate of 30%. The power and chemical industries could reduce carbon emissions by 2.3% and 17.3%, respectively.

Keywords: carbon capture; economics; China; emission reduction

JEL Classification: C51; O14; Q56

1. Introduction

Since industrialization, human activities have caused global temperatures to rise by about 1 ℃, and if global warming continues at its current rate, temperatures will rise by 1.5 ℃ between 2030–2052. In turn, greenhouse gas emissions are one of the main causes of warming, with carbon dioxide emissions accounting for the majority of greenhouse gas emissions (Ipcc, 2013). In the Paris Agreement, countries have pledged to address this environmental issue by proposing their own climate solutions. As of April 2021, 44 countries and the EU have announced net-zero emissions targets, and these countries and regions have pledged to reduce emissions by 70% of global CO_2 emissions.

In order to reduce the increasing concentration of CO_2 in the atmosphere, countries have made many efforts in the last few decades to reduce the consumption of fossil energy, to develop renewable energy sources such as wind, nuclear and hydrogen, to use fuels with shorter carbon chains and CO_2 capture and storage technologies, etc. (Pacala et al., 2007). In particular, carbon dioxide capture and storage (CCS) is considered to make a significant contribution to global emissions reduction by being used in conjunction with a number of emission reduction options (Pacala et al., 2007). CCS technology could reduce global emissions by 50–85% by 2050 (IEA, 2012).

China's resource endowment determines the country's "coal-rich, oil-poor, and gas-poor" energy mix, making most of China's CO_2 emissions come from fossil fuel combustion (Liu et al., 2017). In 2012, 68% of the country's CO_2 emissions came from burning coal, with oil accounting for about 13% and natural gas for about 7%. As the world's largest emitter of CO_2, China's economy is highly dependent on fossil energy sources, and the advent of CCUS technology can greatly mitigate the impact on China's economy when dealing with climate issues. The first CCUS project ran smoothly in 2005, and as the country's attention to climate issues has grown, CCUS technology has gained significant momentum in China, with about 40 projects currently in operation or running intermittently. In September 2020, China proposed a "double carbon goal" of achieving peak carbon by 2030 and achieving carbon neutrality by 2060. Compared to developed countries, China has only 30 years to reach peak carbon and become carbon neutral. As an important technology in the field of carbon emission reduction, CCUS is crucial to China's emission reduction. According to relevant research institutions, under the carbon neutrality target, China's CCUS emission reduction

Table 1. Summary of previous CCUS studies

Reference	Study area	Main conclusions
Rubin et al., 2007	Cost study	The capture costs of PC, NGCC and IGCC were compared under the influence of rising natural gas prices, plant utilization differences, IGCC financing and operating assumptions.
Fan et al., 2019	Cost study	Comparing the full-chain CCS project of coal-fired power plants with other low-carbon power plants, it is concluded that the full-chain CCS project of coal-fired power plants has cost advantages but is greatly affected by coal price and transportation distance.
Fuss et al., 2007	Investment decision study	By analyzing the uncertainty of electricity price and carbon price as well as the policy and market uncertainty based on this, the real option model is used to obtain the optimal time to invest in CCS projects.
Abadie et al., 2008	Investment decision study	Considering the uncertainty of European electricity price and carbon emission market, the binary tree model is used to solve the CCS optimal investment scheme.
Oda et al., 2011	Investment decision study	Under the premise that carbon price and natural gas price are uncertain, this paper compares the break-even between rebuilding environmental power plants and renovating old coal power plants by using discounted cash flow method and obtains the energy price at the best time for CCS investment.
Sen et al., 2016	Forecast carbon emissions	The ARIMA model is used to predict the energy consumption and GHG emissions of pig iron manufacturing industry in India.
Mohamed et al., 2005	Forecasting electricity consumption	The AIRMA model was used to forecast electricity consumption in New Zealand by adding economic and demographic variables.
Xu et al., 2017	Forecast carbon emissions	At the same time, STIRPAT model and GREY (1,1) model are used to divide the total energy consumption into five types, and STIRPAT model is used to predict the consumption of each type of energy, and grey model is used to predict the economic growth, industrial structure change and energy structure change, and the prediction result of carbon emission is obtained by combining them.

demand is 20–408 million tons in 2030 and 0.6–1.45 billion tons in 2050. However, after fifteen years of development from 2005 to 2020, the total emission reduction from operating CCUS projects is only 3.298 million tons. Most scholars have focused on CCUS emission reductions by 2040 or 2060 but have neglected the development process of how to achieve these desired reductions.

This paper sets three development rates, high, medium, and low, to obtain the emission reduction contribution of CCUS at the year 2040. The emission reduction contribution of CCUS is obtained from another perspective and compared with the expected value to consider what growth rate we use to develop CCUS technology is the most appropriate and beneficial for China's economy.

2. Methodology

This paper analyzes and predicts the potential of CCUS technology to contribute to emission reduction in China based on the aggregated data of emission reduction from operating or intermittently operating CCUS projects in China, combined with historical carbon emission data and predicted carbon emission data from some scholars.

2.1 Forecast Contribution to National Emission Reduction

By the end of 2020, China's CCUS emission reduction is 3.298 million tons. The emission reduction potential of CCUS is projected in two growth ways: one is the emission reduction potential under the growth of the number of CCUS projects, and the other way is the emission reduction potential under the growth of CCUS emission reduction.

Contribution under the growing number of CCUS projects

Referring to the development history of CCUS projects in China, in the early stages (2006–2010), one new CCUS project was added each year, while in 2010–2016, the state and government increased their attention and increased funding for research projects related to CCUS program development accelerated during this period, allowing for an average of 3 new projects per year. According to Table 1, it can be concluded that 70% of the CCUS projects that have been proposed or established are above 1 million tons of emission reduction, and large-scale projects are the development trend of future CCUS projects, thus setting the amount of emission reduction for new projects in the future at 1 million tons. Combined with the pace of China's energy consumption restructuring and the 2030 carbon peak target, the CCUS project should grow faster than the previous phase, or at least maintain the growth rate of the previous phase. Therefore, based on the past development rate, we set the number of new CCUS projects in each year in the future as k_1= 1, 2, 3 forecast contribution of emission reductions from CCUS projects by 2040.

The emission reduction contribution can be calculated by the following equation:

$$r_t = \left[\sum CCUS_{cap_{t-1}} + k_1 * CCUS_{cap_{2020}} \times (t - 2020)\right] / emis_t \quad (1)$$

where, r_t represents the emission reduction contribution of CCUS in year *t*, $\sum ccus_{cap_{t-1}}$ is the cumulative emission reduction of national CCUS projects in year *t-1*, $ccus_{cap_{2020}}$ represents the emission reduction of CCUS in 2020, k_1 represents the number of new

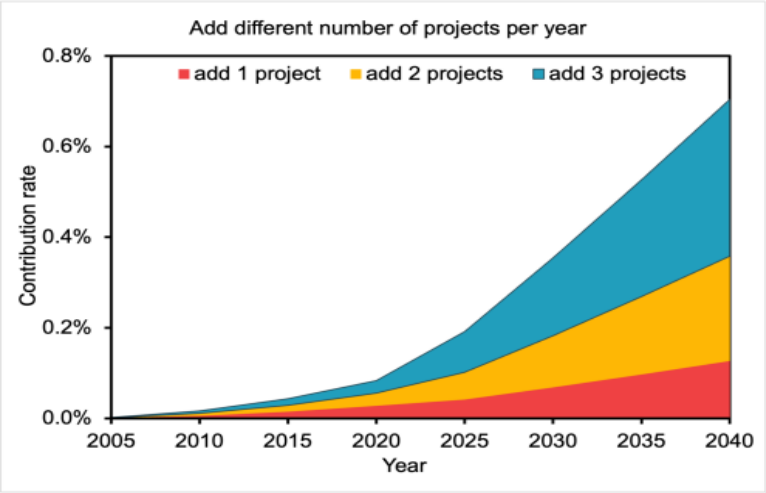

Figure 1. Add different number of projects per year

projects each year, $emis_t$ represents the total national CO2 emission in year t, and t represents the year.

When three new megaton CCUS projects are added each year, the national CO_2 emissions in 2040 will be about 17,269 million tons, and the amount of CO_2 captured by CCUS projects will be about 76,798,000 tons, and the contribution of CCUS technology will be about 0.34%.

Contribution under the growth of CCUS emission reductions

At the end of 2020, the total amount of carbon dioxide captured by the CCUS project is 3.298 million tons, and the annual growth rate of CCUS project emission reduction is set at k_2, k_2 takes 10%, 20%, 30% respectively, to obtain the emission reduction contribution rate:

$$r_t = \left[\sum CCUS_{cap_{t-1}} + CCUS_{cap_{2020}} \times (1 + k_2)^{(t-2020)}\right] / emis_t \quad (2)$$

When CCUS emission reductions are set to grow at different rates, the difference in emission reduction contribution is more significant compared to the way the number of projects grows. When CO_2 capture is increased at a 30% increase per year, the contribution can reach 3.8%, compared to an abatement contribution of about 0.016% when it is increased at a 10% rate. The difference between the two is about 20 times.

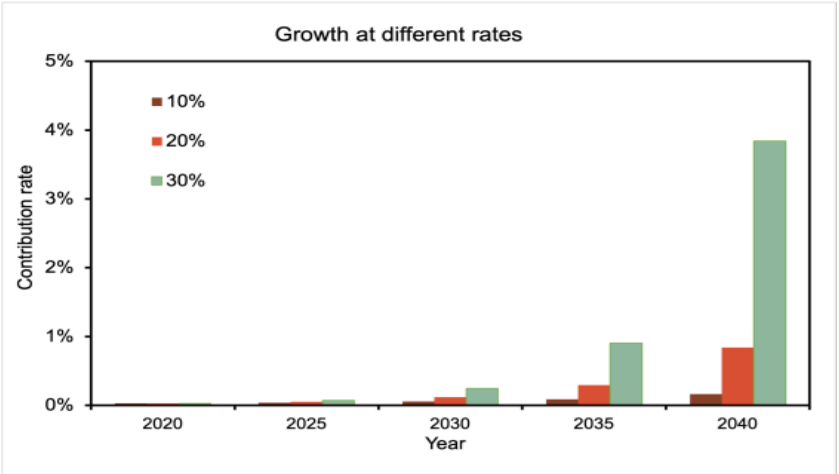

Figure 2. Differences under CCUS emissions reduction growth

2.2 Forecast CCUS Sub-Sector Emission Reduction Potential

To further clarify the emission reduction contribution potential of CCUS technologies, the industrial sectors are subdivided, the actual utilization of CCUS projects and industries are combined to compare the emission reduction contribution potential of CCUS technologies from an industry perspective.

At present, CCUS technology in China's industrial sector is mainly applied in the power industry, chemical industry and petroleum and cement industries, while there are no mature CCUS emission reduction projects of a certain scale in other industries. Therefore, we only predict the potential of CCUS to contribute to emission reductions in four industries: power industry, chemical industry, oil industry, and cement industry. The number of CCUS projects and captures in different industries by the end of 2020 are shown in Table 3.

Table 3. Sub-sector CCUS project information

Sector	Carbon dioxide capture capacity（MT）	Number of CCUS projects
chemical	2.05	13
electricity	0.744	12
petroleum	0.05	3
cement	0.051	2

To set the growth rate of CCUS project emission reductions for the industry is k_3, k_3 takes 10%, 20% and 30%, respectively. The industry emission reduction contribution is calculated as follows:

$$r_{i,\ t} = \left[\sum CCUS_{capi,t-1} + CCUS_{cap_{i,2020}} \times (1 + k_3)^{(t-2020)}\right] / emis_{i,t} \quad (3)$$

where $r_{i,t}$ denotes the CCUS emission reduction contribution of industry i in year t, $\sum ccus_{capi,t-1}$ denotes the cumulative CCUS emission reduction of industry i in year *t-1*, $ccus_{cap_{i,2020}}$ denotes the CCUS emission reduction of industry *i* in 2020, and $emis_{i,t}$ is the CO2 emission of industry *i* in year *t*.

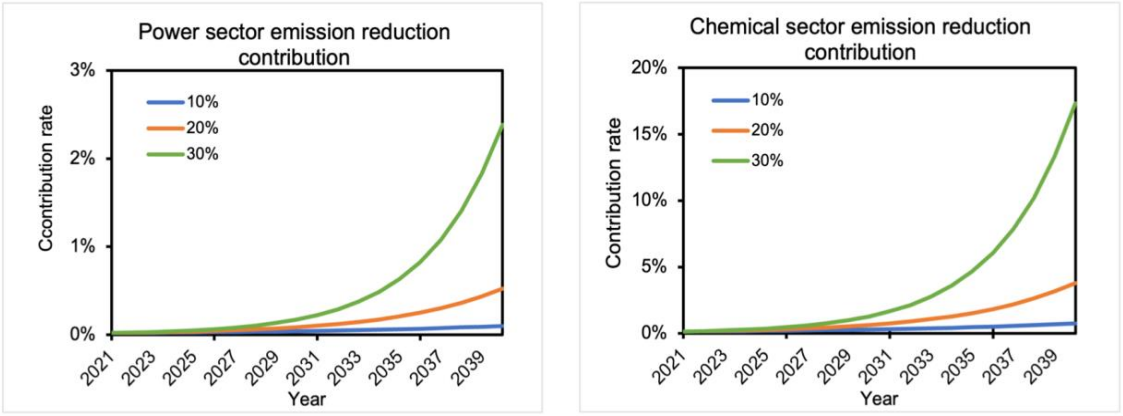

Figure 3. Potential for emission reduction contribution from the power and chemical industries

It can be seen that the contribution of CCUS projects to emission reductions by 2040 varies greatly among industries due to the different current CCUS project emission reductions among industries, resulting in the same growth rate of capture volume. When the

capture volume of the power sector grows at 30%, the contribution of CCUS technology to its emission reduction by 2040 only reaches 2.3%. In contrast, the projected emission reduction contribution of the chemical industry can reach 17.3% at a 30% growth rate, which is much higher than the emission reduction contribution of other industries.

2.3 Forecast CCUS Sub-Regional Emission Reduction Potential

The most important considerations for CCUS source-sink matching are the geographic location and environmental suitability of the emission source and the storage site. The geological and geomorphological characteristics of China vary greatly from region to region, making the development potential of CCUS projects vary from region to region. Moreover, regional differences in economic development will also have an impact on CCUS emission reduction potential.

The regional emission reduction contribution is calculated by the following formula:

$$r_{j,t} = \left[\sum CCUS_{capj,t-1} + CCUS_{cap_{j,2020}} \times (1 + k_3)^{(t-2020)}\right] / emis_{j,t} \quad (4)$$

where j represents the region, $r_{j,t}$ denotes the CCUS emission reduction contribution of region j in year t, $\sum ccus_{capj,t-1}$ denotes the cumulative CCUS emission reduction of region j in year t-1, $ccus_{cap_{j,2020}}$ denotes the CCUS emission reduction of region j in 2020, and $emis_{j,t}$ is the CO2 emission of region j in year t.

The contribution of CCUS technology varies significantly between regions at three different growth rates. The contribution is consistently the largest for the Northeast, where

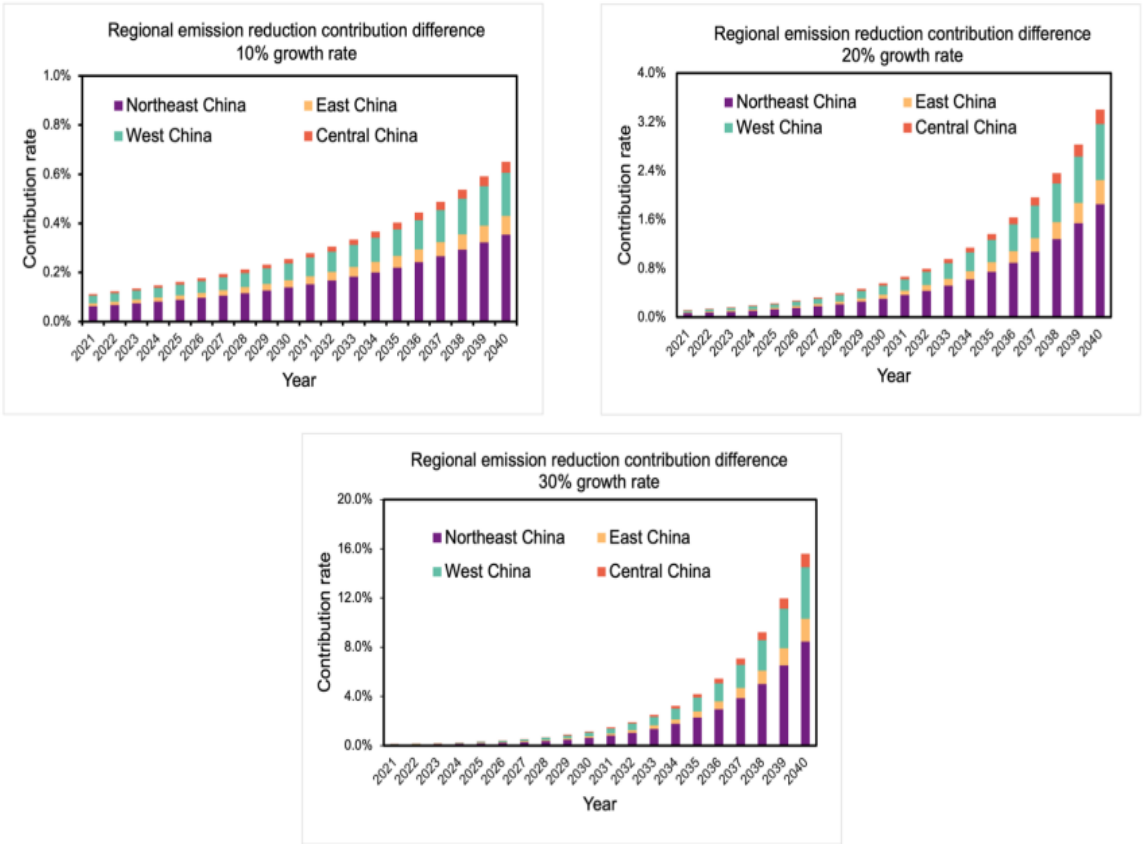

Figure 4. Differences in emission reduction contributions by region

CCUS technology can contribute 8.4% to the Northeast's emissions reduction by 2040 when CO_2 capture grows at 30%. Meanwhile, the contribution of CCUS emission reduction in the eastern region, which is the most developed region in China, is lower than that in the western region, accounting for about 40% of the CCUS emission reduction contribution in the western region. For the central region, the contribution is always the lowest at all three growth rates, and when the emission reduction scale is increased by the largest amount, the emission reduction contribution of CCUS technology is only 1.08%. The reason for this difference in contribution is that the Northeast region has lower carbon emissions compared to other regions, with only 1.641 billion tons of CO_2 emissions projected by 2040, much lower than the Central region's 3.385 billion tons, the Eastern region's 6.181 billion tons, and the Western region's 4.606 billion tons. In addition, the Songliao Basin in northeast China has great geological potential for CO_2 storage due to its good reservoir and cover properties. The large number of oil fields in the northeast also provides a way to utilize CO_2, and the good geological conditions and source-sink match make the CCUS technology the most important contribution to the northeast. The eastern region has a better spatial distribution in terms of source-sink matching, with a large number of chemical companies and coal power plants with high CO_2 concentration emission sources, but the lack of suitable geology for sequestration in the eastern region prevents the large-scale application of CCUS technology, making the predicted contribution lower than that of the western and northeastern regions.

3. Results

As a key emission reduction technology, technical economics of CCUS technology is also of great concern in the process of promoting its utilization. Since the current investment cost of CCUS technology is too high, and the utilization of CO_2 is mainly focused on EOR, industrial and food processing, and geological storage, which have multiple uncertainty effects, it is difficult for CCUS projects to have sustainable and stable income. In the absence of stable revenue, if policies and funds are heavily tilted to support CCUS technology, it is likely that satisfactory emission reduction results will not be achieved.

In order to evaluate the economics of CCUS in future development, we predict the annual cost of new CCUS technology abatement compared with our GDP (Gross National Product) in that year to obtain the ratio of CCUS technology abatement cost to domestic GDP as a measure of the economics of CCUS technology abatement.

The cost of CCUS technology includes economic cost and environmental cost, where economic cost includes fixed cost and operation cost, and environmental cost includes environmental risk and energy consumption emission. The cost per unit of CO_2 reduction is obtained by combining them. The investment cost of CCUS technology will tend to decrease year by year due to the scale effect. In the early stage of CCUS utilization, new CCUS projects are constrained by technology and immaturity of operation management, so the cost is high in the early stage. With the breakthrough of technology bottleneck, the increasing maturity of operation management, some cluster projects share the infrastructure of pipeline, etc., the cost will keep decreasing.

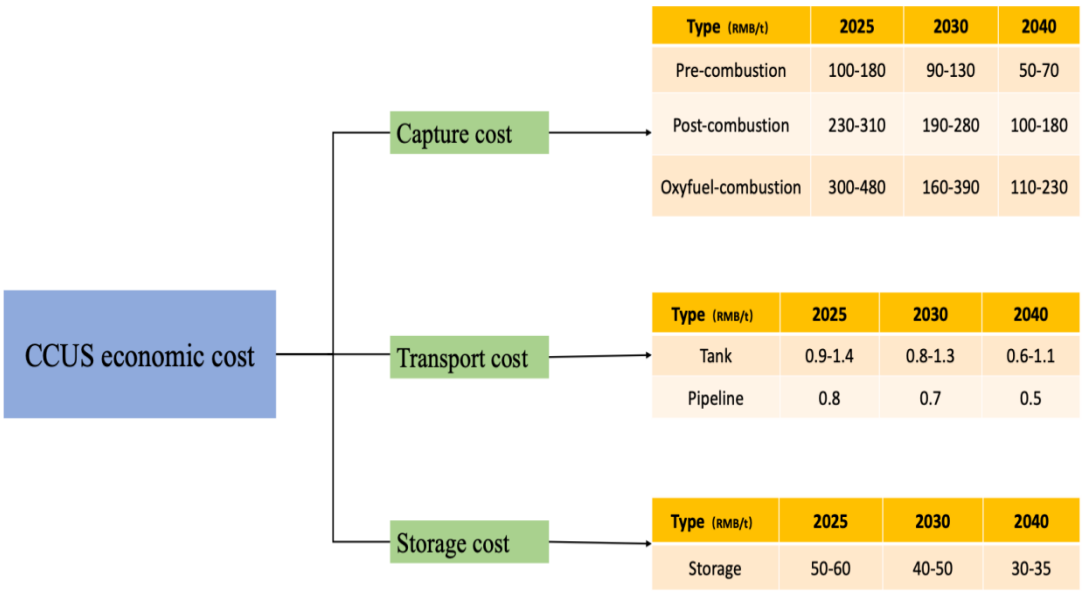

Figure 5. Diagram of CCUS cost

The application of CCUS technology for emission reduction is mainly in the power industry. Compared to pre-combustion capture and oxygen-enriched combustion, post-combustion capture provides a solution for carbon reduction in coal-fired power plants and is currently the most widely used capture method. Therefore, when calculating the economics of CCUS, we make the important assumption that post-combustion capture is the primary capture method used to calculate costs.

The rate of CCUS development is influenced by external uncertainties, so we set different rates of CCUS development. The emission reductions of CCUS technology were obtained for annual growth of 10%, 20%, and 30%. The results are shown in Table 4.

Table 4. CCUS emission reductions at different growth rates

Year/ Reduction	10% growth rate	20% growth rate	30% growth rate
2025	422.83	598.86	824.84
2030	680.98	1,490.14	3,062.58
2035	1,096.72	3,707.96	11,371.14
2040	1,766.27	7,688.82	42,220.26

The growth rate of our GDP is 4.4% and 3.6% during 2021-2030 and 2031-2040, respectively, using the data measured by Goldman Sachs Group. According to the Goldman Sachs Group forecast growth rate, the National Bureau of Statistics 2020 China's gross national product as a starting value, GDP forecast values are shown in Table 5.

Table 5. China's GDP forecast

Year	GDP（Trillion)
2025	1,260,057.3
2030	1,562,761.8
2035	1,865,054.7
2040	2,225,821.6

The cost projections for the CCUS sub-segments are summed to obtain a range of values for the unit cost of abatement of CCUS technology, using the following equation:

$$Cost_t = uc_t * ccus_{cap_t} \quad (5)$$

where, $Cost_t$ represents the meaning of the total cost of CCUS investment in that year, uc_t represents the unit cost, $ccus_{cap_t}$ is the amount of emission reduction at year t, to get the total cost of CCUS emission reduction in that year, and with the GDP forecast value of that year to calculate. Based on the results of the above equation, the ratio of China's CCUS abatement investment to GDP is measured as follows.

Table 6. Percentage of CCUS investment in GDP

Year	Percentage of CCUS investment in GDP
2025	0.00097–0.00243%
2030	0.00101–0.00649%
2035	0.00115–0.01592%
2040	0.00104–0.04099%

The data in the table reflects the CCUS in the continuous development process, due to the growing scale of the deployed projects, although the investment cost per unit of CO2 abatement is decreasing, the cost of investing in CCUS is increasing, from the initial less than 0.001% of the current year's GDP all the way up to about 0.04% of the current year's GDP in 2040. In 2040, CCUS will reduce about 2.44% of the national emissions, which is a capital-saving emission reduction technology with good overall emission reduction economics and a small investment in GDP.

4. Discussion

In this paper, we forecast the contribution of CCUS projects to the nation, industry, and region in 2040 under different development approaches from three perspectives: national, industry, and regional.

The results of the study show that (1) when the number of new CCUS projects is 1, 2, and 3 per year nationwide, and the annual capture scale of the new projects is 1 million tons, the emission reduction contribution of CCUS technology is 0.22%, 0.32%, and 0.44%, respectively. When the amount of carbon dioxide captured by CCUS projects nationwide grows at different percentage rates, with growth rates of 10%, 20%, and 30%, the emission reduction contribution of CCUS projects is 0.51%, 2.08%, and 7.68%, respectively. (2) The types of CCUS project capture are divided into power industry, chemical industry, petroleum industry, and cement industry by industry. At present, the application of CCUS technology is mainly concentrated in the power and chemical industries. By 2040, the ease of reducing emissions using other technologies will be different for different industries due to the different carbon emissions in different industries. Therefore, the industry emission reduction contribution of CCUS technology at 2040 varies. The contribution of CCUS to industry emission reduction is 0.09%, 0.52%, and 2.38% when the annual CO_2 capture scale of power industry grows at 10%, 20%, and 30%, respectively. When growing at the same rate, the contribution of CCUS to the

industry's emission reduction in the chemical industry is 0.72%, 3.78%, and 17.31%, respectively. (3) When the country is divided into eastern, western, central, and northeastern regions according to the economy, the northeastern region has been the largest contributor to emission reduction by CCUS technology because the industry is less developed than other regions but has the Song Liao Basin and a large number of oil fields that can utilize CO_2, and the regional contribution to emission reduction by 2040 is 0.35%, 1.85%, and 8.47%. The main reason behind this is that the central region lacks the geological conditions to promote the use of CCUS and cannot generate profit for the project.

In order to predict the contribution of CCUS technology to national, industry and regional emission reduction, and in the light of the specific development situation in China, the following policy recommendations are made for the cause of emission reduction in China:

1. The future development of CCUS technology should be aimed at clustering and commercialization. the biggest advantage of CCUS projects, when they are scaled up, is that they can reduce costs. For example, after the establishment of CCUS industrial parks, some of the infrastructure can be shared to a certain extent, reducing the initial investment cost of the project. After the commercialization of CCUS technology, the project itself will be able to form a certain "blood-making" capacity with "CO_2" as the core value, which will enable the project to maintain long-term operation.
2. National policies subsidize the cost of CO_2 transportation process. From the predicted results, the contribution of CCUS varies greatly from region to region. Less economically developed regions have good geological storage conditions, while economically developed regions lack geological conditions for utilization and storage. However, the transportation of CO_2 captured in developed regions to geologies where it can be sequestered will incur high costs, so the state can subsidize the CO_2 transportation link in CCUS to further promote the resource allocation and utilization in each region.
3. Pay attention to other renewable energy sources and energy restructuring. When the amount of carbon dioxide captured by CCUS technology increases at 30%, the contribution to China's emission reduction is still only 7.68%. Therefore, in addition to CCUS technology, we should also focus on other green energy technologies and energy structure adjustment to work together to achieve carbon neutral.

Conflict of interest: None

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Education, Labor Mobility and Relative Rural Poverty

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Abstract: Relative poverty has become more important since China eliminated absolute poverty. Based on the sample data of rural households in CFPS 2018, this paper studies the impact of education and labor mobility on the relative poverty of rural households. First, A-F is used to construct a multi-dimensional relative poverty index to measure the relative poverty status of rural households. The income dimension uses the relative poverty index of income instead of the absolute poverty line, and then establishes the Logit binary choice model for econometric analysis and robustness test. The results show that: (1) Education, labor mobility and their interactions have significantly reduced the probability of rural households falling into multidimensional relative poverty; (2) Regional heterogeneity exists in the impact effects, education and labor mobility in inland areas The poverty reduction effect for the relative poverty of rural households is better than that of coastal areas. These results are of great significance for exploring the relative poverty in my country's rural areas and their causes.

Keywords: education; labor mobility; relative poverty

JEL Classification: D10; I32; J24; J61

1. Introduction

China has eliminated absolute poverty in 2020 and built a well-off society in an all-round way. However, the elimination of absolute poverty does not mean the elimination of poverty, but a shift from absolute poverty to relative poverty. Common prosperity is the essential requirement of socialism, and how to alleviate the problem of relative poverty has the urgency of the times.

The concept of relative poverty can be traced back to Shorrocks and Townsend (1980). Sen (1999) rejected Townsend's relative interpretation, and proposed a poverty theory of feasible capability, which also expanded the connotation of poverty from one-dimensional to multi-dimensional. Education is an important factor in the causes of relative poverty. One main approach is the accumulation of human capital advocated by Becker (1994). Another way that education affects poverty is intergenerational transmission. Zou and Zheng (2014) explained the problem of persistent poverty in low-income families from the perspective of the risks of education investment and decision-making. For poor rural families, the income sent home by migrant workers has become the main source of family income (Duyang & Pu Zhishui, 2003). Fan and Jiang (2016) used CFPS data and found that the empirical analysis found that rural labor mobility not only improved the household income of farmers, but also reduced the possibility of poverty.

Education and labor mobility are of great significance to poverty alleviation. However, most existing studies focus on absolute poverty, and there are research gaps on relative poverty. This paper will study the impact of education and labor mobility on relative poverty. In addition, it will explore the impact of the interaction between education and labor on relative poverty.

2. Methodology

2.1. Data Source

The data in this article comes from the China Family Panel Studies (CFPS) of 2018, and the sample covers 25 provinces (municipalities and autonomous regions) across the country, which is nationally representative. The research object of this article is rural households, so only the sample of urban households is deleted. According to the completeness of other variable data and the matching degree between the individual and the family sample, this paper screened the data and finally got 4905 family samples.

2.2. Measurement of Relative Poverty

In the multidimensional poverty measurement method, the A-F double critical value method is used. In the income dimension, in order to reflect the difference between relative poverty and absolute poverty, this paper uses relative income poverty indicators to replace the absolute poverty income standard line. According to the Multidimensional Poverty Index (MPI) evaluation system proposed by the United Nations Development Program (UNDP) in 2010 and existing research results, considering the availability of data, this article selects four indicators of income, education, health and living standards to construct Multidimensional poverty index.

First, identify a single dimension of poverty. Set different poverty deprivation thresholds in different dimensions to determine whether it is in a state of poverty deprivation in this dimension. For example, for a certain family, if its status in this dimension is lower than the critical value, it means that the family is in a state of poverty deprivation in that dimension, and the value is assigned to 1 and vice versa to 0. The specific formula is expressed as follows:

$$g_{ij} = \begin{cases} 1, & if\ X_{ij} < Z_j \\ 0, & if\ X_{ij} \geq Z_j \end{cases} \quad (1)$$

Z_j represents the deprivation cut-off in the jth dimension, and X_{ij} represents the deprivation state of the ith family in the jth dimension. When X_{ij} is less than the critical value Z_j, the ith household is in a state of poverty deprivation on dimension j.

Secondly, the deprivation scores on various dimensions are weighted and averaged to judge the multidimensional poverty status. First, set the weight of each dimension to w_j and add up to 1. The formula is as follows:

$$c_i(k) = \sum_{j=1}^{n} w_j\, g_{ij} \quad (2)$$

The n represents the total number of households, w_j is the weight on the *j*th dimension, and k is the multidimensional deprivation cut-off value. Households are poor when the total number of deprivation dimensions $c_i(k)$ is greater than or equal to the cut-off value k, while households below the cut-off value are considered non-poor. The total number of poor people is calculated and expressed as q. Therefore, the poverty state is affected by both $Z_j$and c_i, which is the double critical value.

This paper uses 50% of the country's per capita disposable income to measure relative poverty in the income dimension. If the per capita household income is less than 50% of the disposable income of the national residents, it is in a state of relative poverty, otherwise it is a non-poor family. The specific indicator system is shown in Table 1.

Table 1. Multidimensional poverty indicators

Dimension	Metric	Deprivation Cutoff	Weight
economy	Per capita household net income	Less than 50% (14,114) of the national per capita disposable income in 2018, it is assigned to 1	0.2
education	Years of education	Adults (16 years old) have education for less than 9 years, assigned 1	0.2
health	The proportion of medical expenditure	In the previous year, household medical expenditure accounted for more than 40% of the total expenditure of 1	0.2
surroundings	drinking water	Well water and other non-clean water source assignment value 1	0.1
	Energy use	Non-clean energy source such as firewood is assigned a value of 1	0.1
social development	Family culture and education expenditure	The proportion of cultural and educational expenditure in net income was less than 10% of 1	0.2

2.3. Main Variables

Core variables: The variable explained in this paper is the multi-dimensional relative poverty state (rmpi), and the total score of deprivation is obtained by the A-F calculation method above. Set the multi-dimensional poverty critical value k to 1/3. If the total deprivation score is higher than k, it is in a multi-dimensional relative poverty state, otherwise it is a non-poverty state. The relative poverty status is assigned a value of 1, and the non-poverty status is assigned a value of 0. The core explanatory variables are the average number of years of education in the family (edu) and labor mobility (outinc). Labor mobility is expressed by the amount sent home by family migrants in the CFPS 2018 questionnaire. The samples of households without migrant workers and those who did not send money home are all assigned a value of 0.

Control variables. This paper selects four control variables: region (area), social subsidy (soc), transfer income (trans), and the number of people eating at home (peo). These variables also affect the poverty status of family, but they are not the focus of this article, so put them in the control variables. Among them, the area is divided into coastal and inland areas; social subsidies and transfer income measure the assistance status of the family, and the amount of subsidy will affect the poverty status; the number of people eating at home reflects the family's dependency ratio. The variable meanings and descriptive statistics are shown in Table 2.

Table 2. Key variable definitions and descriptive statistics

Variable	Definition	N	Mean	Sd	min	max
rmpi	The multidimensional poverty critical value K is set at 1 / 3, and the total deprivation score above k is assigned in a relative poverty state of 1, otherwise 0.	4,905	0.781	0.414	0	1
edu	Education level per capita (units: year).	4,905	5.523	3.080	0	19
outinc	Measured by the amount of the person send home (units: CNY).	4,905	11,710	19,074	0	200,000
edu_outinc	The interactive effect of education and labor mobility	4,905	71,451	146,100	0	3,200,000
area	The coastal area was assigned 1, and the inland area was assigned 0.	4,905	0.265	0.441	0	1
soc	Social subsidies received by families (units: CNY).	4,905	0.0169	0.129	0	1
trans	Total transfer income earned by the family. (units: CNY).	4,905	5,786	31,547	0	1,000,000
peo	The number of people in the family who usually eat.	4,905	3.599	1.816	1	21

2.4. Model

The explained variable of this article is whether it is in a multi-dimensional relative poverty state, which is a binary discrete variable, so this article uses the Logit Model for empirical analysis. First, express the relative poverty state of the explanatory variable in the form of probability:

$$\begin{cases} P(y = 1|X) = F(x, \beta) \\ P(y = 0|X) = 1 - F(x, \beta) \end{cases} \tag{3}$$

It is further expressed as the logit model as:

$$P_i = F(y_i) = F(\alpha + \beta x_i) = \frac{1}{1 + e^{-y_i}} = \frac{1}{1 + e^{-(\alpha+\beta x_i)}} \tag{4}$$

The explained variable is converted into probability through logistic probability distribution function F(y), and the above model is converted to obtain:

$$ln\frac{P}{1-p} = logit(P) = \beta_0 + \sum_{i=1}^{k} X_i\beta + \varepsilon \tag{5}$$

Among them, is defined as the chance ratio. In this article, it refers to the ratio of the probability of a family in relative poverty to the probability of not being in relative poverty. When estimating the model with maximum likelihood estimation, the dependent variable y obtained is not whether it is in relative poverty in this paper, but the logarithm of the chance ratio, also called odds ratio or odds ratio.

3. Results and Discussion

3.1. Regression Results

Table 3 reports the benchmark regression results of the logit model. Two regressions were performed according to whether the control variables were added. Among them, the robust standard errors are in parentheses. Model (1) does not add control variables, the left column reports the probability ratio, and the right column reports the variable coefficients.

From the results, both education (*edu*) and labor mobility (*outinc*) are very significant, and the interaction effect of education and labor mobility (*edu*outinc*) is also significant at the

0.1 level. Judging from the sign of the coefficient, the coefficients of the two core explanatory variables of education and labor mobility are both negative, indicating that the increase in the number of years of education and labor mobility will reduce the probability of rural families in relative poverty. The odds ratio (β) shows that for every increase in the average number of years of education of rural households by one unit, the probability of rural households in relative poverty is 0.69 times the original probability, that is, the probability of being in relative poverty drops by 31%. Although the odds ratio of family labor mobility is close to 1, it is still less than 1, indicating that labor mobility will also reduce the probability that rural families are in relative poverty.

The possible reason why the chance ratio of labor mobility in this article is close to 1 is that this article uses yuan as the unit of money sent home by migrant workers, so the regression results show this. But the regression result is still significantly negative, which does not affect our judgment. Therefore, the regression results of the core explanatory variables confirm the research hypothesis of this article: education, labor mobility, and the interactive effects of the two will reduce the probability of rural families in relative poverty.

Table 3. Regression results

	(1)		(2)	
Varibales	Odds ratio	β	Odds ratio	β
edu	0.6913638***	-0.369***	0.7026641***	-0.353***
		(0.0165)		(0.0167)
outinc	0.9999792***	-0.0000208***	0.9999772***	-0.0000228***
		(0.00000492)		(0.0000049)
edu_outinc	1.000001*	0.00000117*	1.0000001**	0.00000135**
		(0.000000632)		(0.000000622)
area			0.8189709**	-0.200**
				(0.0850)
soc			2.3567713**	0.862**
				(0.416)
trans			0.9999973**	-0.00000266**
				(0.00000127)
peo			1.099234***	0.0946***
				(0.0238)
Constant	43.2503***	3.767***	30.16122***	3.407***
		(0.126)		(0.161)
Observations		4,905		4,905
chi-square	877.43***		909.33***	
	(0.000)		(0.000)	
H-L chi2	12.68		14.36	
	(0.1232)		(0.0729)	

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Model (2) is the regression result after adding control variables. Compared with model (1), the original estimation results are not changed after the control variables are added, and the results are still significant on the core variables. In terms of chance ratio, the chance ratio of model (2) is reduced, that is, the probability of being in relative poverty is reduced, but the results of the two models are not much different. The control variables are basically significant, indicating that the model has a better fitting effect.

The area variable is added to the control variable to judge the regional heterogeneity of the result. The area (*area*) is represented by two values, 1 is the coastal area, and 2 is the inland area. The β coefficient of Area is less than 0, and the probability ratio is less than 1. This shows that the probability of rural households in the coastal areas (*area* = 1) being relatively poor is 0.82 times that of the rural households in the inland areas (*area* = 0). This result may be related to the economic differences between the coastal and inland areas. Compared with the inland areas, the coastal areas have a higher level of economic development, and even the probability of rural poverty is lower than that in the inland areas.

In order to make the results of this paper more convincing, the overall effect of the model is tested here. From the chi-square value of LR, the chi-square of the two models is significant, and the overall fitting effect of the model is better. The model is then subjected to the *Hosmer & Lemeshow* test (*H-L test*). The H-L test is based on the difference between the predicted value obtained by the model and the actual observed data to determine whether it is significant. The larger the Sig obtained by H-L test, the better the overall fitting effect of the model. According to Table 3, Sig = 0.1232 > 0.5 for model (1), Sig = 0.0792 > 0.05 for model (2). The test values of neither model reached the significance level of 0.05, indicating that the overall model was well adapted.

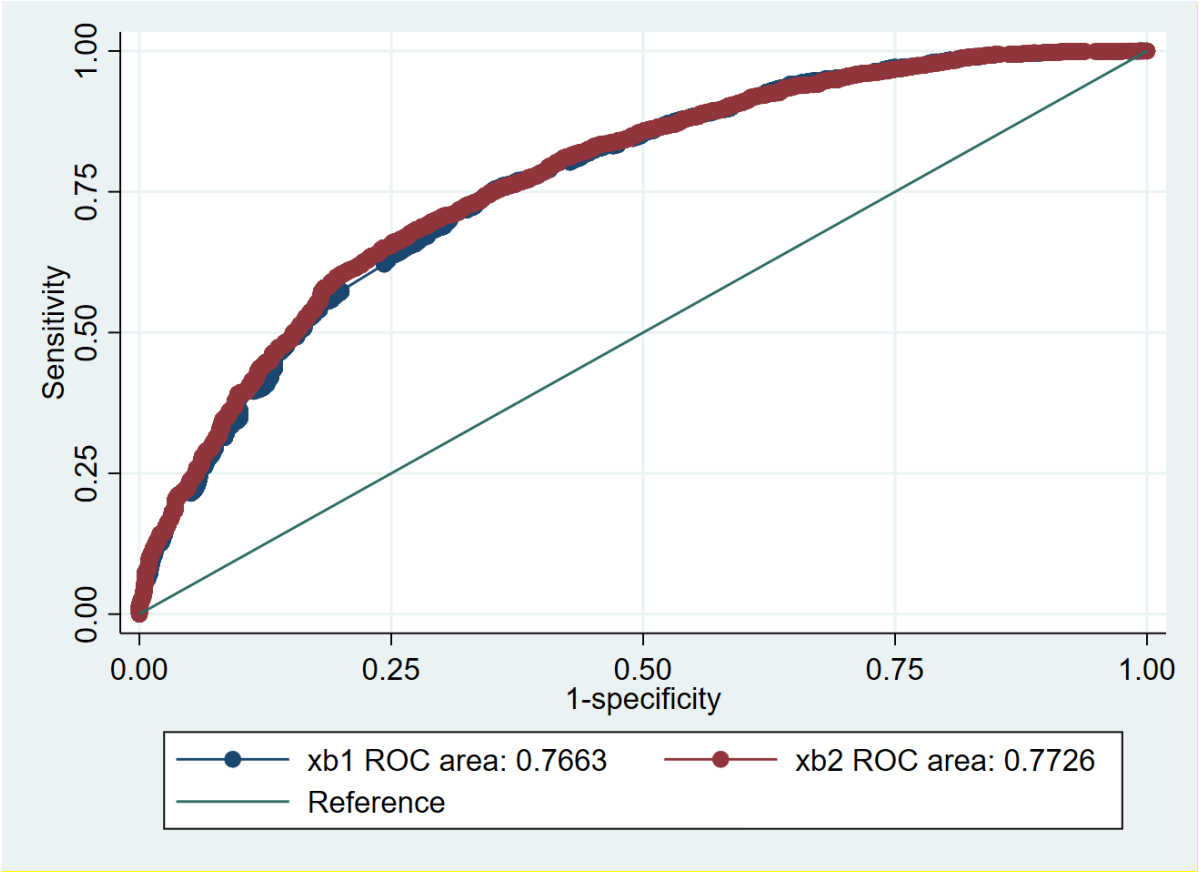

Figure 1. The ROC curve and the AUC value of models (1) and (2)

Figure 1 shows the ROC curves and AUC values for the two models. Blue curve indicates model (1) and AUC = 0.7663. Red curve indicates model (2) and AUC = 0.7726. It can be

seen that the AUC value of both models is close to 8, indicating that the model has good regression quality as a whole.

3.2. Robust Test

In this paper, the robust test is carried out from the aspects of changing the model setting form and adjusting the measurement method of core variables, and all the results are shown in Table 4.

Change the model setting. OLS regression was used while adjusting the measure of relative poverty. The relative poverty in this paper was determined using 1/3 of the deprivation score as the cut-off value, and for robustness testing, OLS regression was performed directly using the deprivation score as the explanatory variable. The results are reported in the model (3) of Table 4, and all variables pass the significance test and the coefficient symbols are as expected. The research hypothesis in this paper is tested.

Adjust the measurement of the number of years of schooling per household. The number of years of schooling of children in a family may not yield economic returns due to time, which in turn affects the relative poverty of the family. Therefore, the average number of years of schooling of adults in the family can be used to measure the educational level of rural families, and the age boundary between adults and children is divided into 16. The result table is shown in model 2 (4), and the significance test of each variable is passed, and the size of the chance ratio is also as expected. The research hypothesis in this paper is tested.

Adjust how labor mobility is measured. Labor mobility is measured using the binary variable of whether rural households are migrant workers, and the results are shown in the model in Table 4 (5). Except for the insignificant interaction, the other variables passed the significance test, which basically verified the research hypothesis in this paper.

Table 4. Robustness test

	(3)	(4)	(5)
Varibales	β	Odds	Odds
edu	-0.0282***	0.7321768***	0.7295707***
	(0.000828)	(0.0148)	(0.0251)
outinc	-0.00000195***	0.9999781***	1.102723*
	(0.000000263)	(0.00000517)	(0.0532)
edu_outinc	0.000000103***	1.000001**	0.9905793
	(0.0000000328)	(0.000000551)	(0.00714)
area	-0.0182***	0.8084854**	0.8075469**
	(0.00583)	(0.0839)	(0.0848)
soc	0.0370**	2.397849**	2.515133**
	(0.0174)	(0.442)	(0.416)
trans	-0.000000339***	0.9999971**	0.9999974**
	(0.0000000939)	(0.00000126)	(0.00000125)
fp2	0.00738***	1.197105***	1.081077***
	(0.00132)	(0.0231)	(0.0233)
Constant	0.637***	21.95543***	18.87656***
	(0.00788)	(0.150)	(0.216)
Observations	4,905	4,905	4,905
R-squared	0.230		

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

4. Conclusions

Based on the sample data of rural households in CFPS 2018, this paper studies the impact of education and labor mobility on the relative poverty of rural households. Through literature review, the theoretical model of dynamic game with incomplete information is established and the research hypothesis of this article is put forward. Subsequently, an empirical analysis was carried out. First, the A-F double critical value method was used to measure the relative poverty of rural households in multiple dimensions. In the construction of multidimensional poverty indicators, the income dimension uses the relative poverty indicator of income. The specific method is to use 50% of the national per capita disposable income as the critical value. Subsequently, a dual choice model was constructed, and the Logit model was used to establish an econometric model for empirical testing.

The results of the study show that: (1) Per capita years of education and labor mobility will significantly reduce the probability of rural households falling into multi-dimensional relative poverty, and the interactive effect of education and labor mobility will also affect the relative poverty; (2) Education and labor force reduction The poverty effect has regional heterogeneity. The mitigation effect of education and labor mobility on relative poverty is lower than that of inland areas, and education and labor mobility in inland areas greatly reduce the probability of relative poverty.

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GIS-Based Research on the Spatial Trajectory Migration of Shaanxi Province's Demographic, Economic and Industrial Centers of Gravity

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Abstract: This article analyzed the movement trajectory of population center of gravity, economic center of gravity, and industrial center of gravity of Shaanxi Province from 2000 to 2020 using GIS. The following are the key findings. (1) From 2000 to 2012, Shaanxi Province's economic center of gravity, population center of gravity, and industrial center of gravity shifted northeast. (2) After 2013, the economic and population centers of gravity shifted swiftly to the southwest, with the economic center of gravity moving more quickly than the population center of gravity. (3) The degree of longitude correlation between the center of gravity of the primary industry and the center of gravity of the economy and population was the highest, whereas the secondary and tertiary industries were the primary cause of the economic development gap between the north and south of Shaanxi Province, and the tertiary industry was the leading factor for the North-South population migration in Shaanxi Province. (4) Population, economy, and the industrial core of Shaanxi Province were influenced by institutional change, industrial structure, urbanization, and public education.

Keywords: population gravity center; economic gravity center; industrial gravity center; center of gravity shift; coupling; variation consistency

JEL Classification: R12; J11; L10

1. Introduction

Regional development imbalance and lack of coordination have long been important issues in China's growth. Principal paradox in contemporary Chinese society is between imbalanced and inadequate development and the people's ever-increasing desire for a better living. In the current era, the implementation of the regional coordinated development strategy has become one of our most important national strategies. Consequently, studying regional development is of significant practical importance. The trend of economic and population development is an essential indicator of the condition of a region's economic development and a significant factor in formulating and adjusting development policies. Population movement is a significant component in determining the level of regional economic growth. The migration of people increases the labor force and the consumer market. Simultaneously, the development situation of regional economy responds to the flow

of population, and the robust momentum of regional economic development has become a significant factor in the flow of population.

Population center of gravity refers to the equilibrium point of population distribution in the spatial plane in the research region. It is typically used to measure the equilibrium state of population distribution in a region by comparing it to the geometric center of that region. As natural, socioeconomic, and regulatory circumstances change, population and economy are redistributed, and the demographic and economic gravitational centers will shift correspondingly. The study of the moving trajectory of the population and economic center of gravity can reveal the characteristics and causes of the spatial changes of population and economic distribution and provide a decision-making foundation for the formulation of population and economic development policies and regional socioeconomic development planning. Geographic information system (GIS) plays an increasingly vital role in regional population and economic distribution as a result of the rapid development and widespread use of geographic information technology. Numerous experts in the United States have effectively adapted GIS spatial analysis to population and economic studies. Therefore, this paper chooses to carry out further research based on GIS technology.

The center of gravity model can explain the spatial distribution characteristics and evolution law of social and economic phenomena, as well as the direction and equilibrium of regional development (Grether & Mathys, 2008) and is frequently employed to investigate the evolution of population and economic center of gravity. Numerous studies have been conducted using the center of gravity model. For instance, Walker (1874) was the first to utilize the center of gravity model to research social science issues. He investigated the movement and evolution of the American population's center of gravity under the effect of Western development and other causes. Later, Bellone and Cunningham (1993) enhanced the concept of economic center of gravity by defining the regional center of gravity as the mass center of people in a region. In China, Fan and Taupman (1996) were the first to utilize the barycentric model to examine the evolution trend of the level of provincial agricultural industrialization. Since then, researchers have employed the center of gravity model (Hu et al., 2011), standard deviation ellipse (Li et al., 2015), coupling model (Gao et al., 2018), geographic detector (Hu et al., 2019), and other research methods to analyze urban agglomeration (Wang et al., 2011), provincial region (Hu et al., 2011), municipal region (Wu, 2014), and river basin (Wang et al., 2013).

According to the available literature, the majority of studies concentrate on determining the evolution trend of national or regional demographic or economic factors. Therefore, the possible marginal contribution of this paper, beginning with a province, analyzes the evolution trend of population and economic factors of the center of gravity, as well as the influence factors of population and economy, in order to provide some development recommendations for local development.

2. Research Methods and Data Sources

2.1. Research Methods

- Center of gravity model

The center of gravity model offers distinct advantages for examining the spatial variations of constituents. By analyzing the movement direction and distance of the center of gravity position of elements, it can intuitively and precisely reveal the distribution law and evolution characteristics of the elements in two-dimensional space. It is primarily used in center of gravity studies, such as population change and economic development. By creating a model of population and economic migration's center of gravity, this article analyzes the dynamic evolution characteristics and geographical matching relationship of population and economic center of gravity migration in Shaanxi Province during the past two decades.

Suppose that a large region consists of *n* small regions, that the geographical coordinate of the I-th region is (x_i, y_i), and that m_i represents the quantity value of a certain attribute (such as economic aggregate) of the I-th region, then the calculation formula for the geographical coordinate of the center of gravity of a certain attribute in this region is:

$$\bar{x} = \sum m_i x_i / \sum m_i \quad (1)$$

$$\bar{y} = \sum m_i y_i / \sum m_i \quad (2)$$

- Distance of center of gravity

The moving distance of the center of gravity is an important metric for analyzing the center of gravity's evolution trajectory. The equation is as follows:

$$D_i = k \cdot \sqrt{\left(\overline{x_\iota} - \overline{x_j}\right)^2 + \left(\overline{y_\iota} - \overline{y_j}\right)^2} \quad (3)$$

$(\overline{x_\iota}, \overline{y_\iota})$ and $(\overline{x_j}, \overline{y_j})$ in Formula (3) can only represent the geographical coordinates of the economic center of gravity as it changes over time, or they can represent the geographical coordinates of the economic center of gravity with different attributes, such as the industrial center of gravity and the population center of gravity. Where k (k = 111,111 kilometers (km)) denotes the conversion coefficient from earth surface coordinate unit(degree) to plane distance (km).

- Analysis of coupling

In the spatial distribution of deviation, economic center of gravity and population center of gravity reflect primarily two aspects. First, their geographical locations do not intersect during the same time period; second, the direction of their trajectories in the time series is different. Therefore, this study focuses primarily on the coupling between the economic center of gravity and the population center of gravity in terms of their spatial distribution and the consistency of the direction of change.

  - Spatial overlap

The spatial overlap is determined by the distance between the two objects. If the distance is great, the coupling is low; if it is short, it is high. E and P are coordinates of the same year that have distinct barycenters. Here is the formula for calculating:

$$S = d_{G_E G_P} = \sqrt{(x_E - x_P)^2 + (y_E - y_P)^2} \quad (4)$$

o Consistency of variation

Consistency of variation refers to the Angle between two kinds of barycenter moving vectors relative to the time point, denoted by θ, where the value range of θ is [0,π], and cosC denotes the general exponent, which is identical to the property. The bigger C, the greater the variability; when C = -1 or 1, the variability is either consistent or inconsistent. Suppose the center of mass is located at a certain point in time and the change in latitude and longitude, respectively, is Δx and Δy. The formula for calculation is as follows:

$$C = \cos\theta = \frac{(\Delta x_E{}^2+\Delta y_E{}^2)+(\Delta x_P{}^2+\Delta y_P{}^2)-[(\Delta x_E{}^2-\Delta y_E{}^2)+(\Delta x_P{}^2+\Delta y_P{}^2)]}{2\sqrt{(\Delta x_E{}^2+\Delta y_E{}^2)(\Delta x_P{}^2+\Delta y_P{}^2)}} = \frac{\Delta x_E\Delta x_P+\Delta y_P\Delta y_P}{\sqrt{(\Delta x_E{}^2+\Delta y_E{}^2)+(\Delta x_P{}^2+\Delta y_P{}^2)}} \quad (5)$$

2.2. Source of Data

This paper uses the gross domestic product (GDP), added value of the primary (secondary, tertiary) industry, and population of ten cities in Shaanxi Province since 2000. In order to avoid inconsistency from affecting the results of the industrial index calculation, the basic data are rectified prior to calculation. As the city's geographical coordinates, this paper selects the longitude and latitude of the province's center of gravity.

Calculating the demographic center of gravity, economic center of gravity, and industrial center of gravity requires geographic and attribute data. Shaanxi Province's administrative map is vectozed using ArcGIS 10.3 and GeoDa, and its coordinate system is a projection coordinate system. The source of the attribute data is the Shaanxi Provincial Statistical Yearbook, which primarily consists of the total population data, economic data, and industrial data for each urban area in Shaanxi Province at the end of 2020.

3. Analysis of the Evolution and Migration Trajectory of the Population Center of Gravity, Economic Center of Gravity, and Industrial Center of Gravity

3.1. Evolution of the Population's Center of Gravity in Space and Time

By adopting the calculation method of gravity center and utilizing GIS platform to calculate the population data of prefecture-level cities in Shaanxi Province, the geographical coordinates of population center of gravity of prefecture-level cities in Shaanxi Province from 2000 to 2020 and the spatial dynamic migration and change rule of population center of gravity from 2000 to 2020 are obtained. As shown in Figure 1, the population center of Shaanxi Province remained in Jingyang County, Xianyang City from 2000 to 2020. Since the year 2000, the population center of Shaanxi Province has moved between 108.75- and 108.78-degrees east longitude and 34.63- and 34.66-degrees north latitude. The population center of gravity in Shaanxi Province changed to the northeast from 2000 to 2015, to the southeast from 2016 to 2020.

From the standpoint of the movement direction and distance of the center of gravity, the geographical distribution of the population exhibited two stages of change. The first stage: from 2000 to 2015, the population moved approximately 5.43 km northeast at a sluggish pace. The second phase: from 2015 to 2020, the township was moved approximately 5.29 km to the southeast. In instance, the moving distance in 2018 and 2020 was 1.50 km and 1.78 km,

respectively, and was the greatest in these two years. Possible causes include the development and utilization of various coal, oil, natural gas, and other energy sources in northern Shaanxi in recent years, the development of red tourism to drive the economy, and the improvement of the environment, causing more people to settle in northern Shaanxi, and the population series promoting the population center of gravity to shift to the northeast.

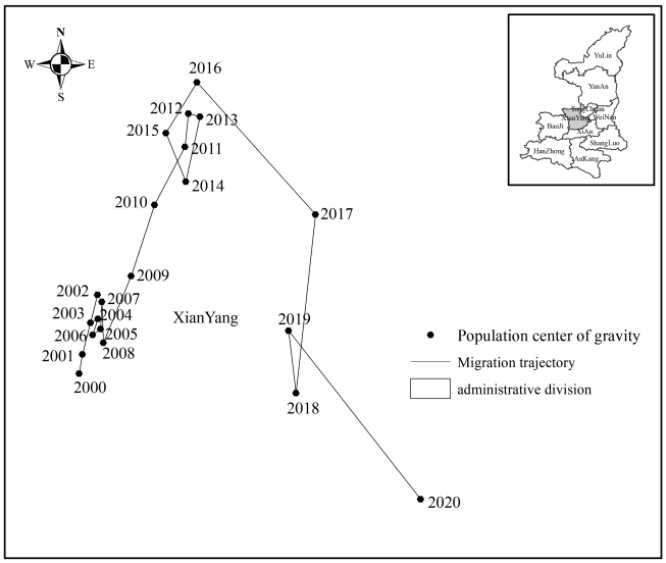

Figure 1. Migration trajectory of the population's gravitational center in Shaanxi Province

3.2. Evolution of the Economic Center of Gravity in Space and Time

The economic center of gravity and its displacement are dependent on the geographical distribution and adjustment of economic activities, and its evolution track reflects the alterations in the spatial distribution of economic activity. Figure 2 shows that since the year 2000, the economic center of Shaanxi Province has moved from the coordinates of 108.75-108.78 degrees east longitude and 34.63-34.66 degrees north latitude. In terms of administrative divisions, it was located in the Jingyang County from 2000 to 2003, the Sanyuan County from 2004, and the Tongchuan City from 2005 to 2020. Overall, the economic center of gravity shifted to the northeast, but from 2012 to 2015 it shifted to the southwest and from 2016 to 2019 it shifted back to the northeast. Based on an examination of the statistics, it can be inferred that the rate of economic contribution to the northeast is rising steadily.

The geographical distribution of the population exhibited two stages of change based on the direction and distance of the center of gravity. The initial phase: from 2000 to 2012, it migrated approximately 426.32 km to the northeast. During the second phase, from 2013 to 2020, the township was moved 569.83 km to the southwest. In particular, the travelling distance in 2017 was 164.68 km and in 2018 it was 166.67 km. The greatest moving distance was two years. In recent years, the northern region of Shaanxi has become rich in coal, oil, natural gas, rock salt, and other resources that can be exploited under favorable conditions. Future national energy and chemical industry center of importance. At the same time, the economic belt along the Great Wall has been viewed as a new economic growth point and breakthrough point for Shaanxi Province, as well as the development focal point. It provides

favorable transportation conditions for the rapid development of northern Shaanxi, the construction of an energy and chemical industry base, and the growth of tourism, and indirectly encourages the development of northern Shaanxi and the growth of the GDP. The regional economic gravitational center will ultimately shift to the northeast as a result of such a large amount of economic input.

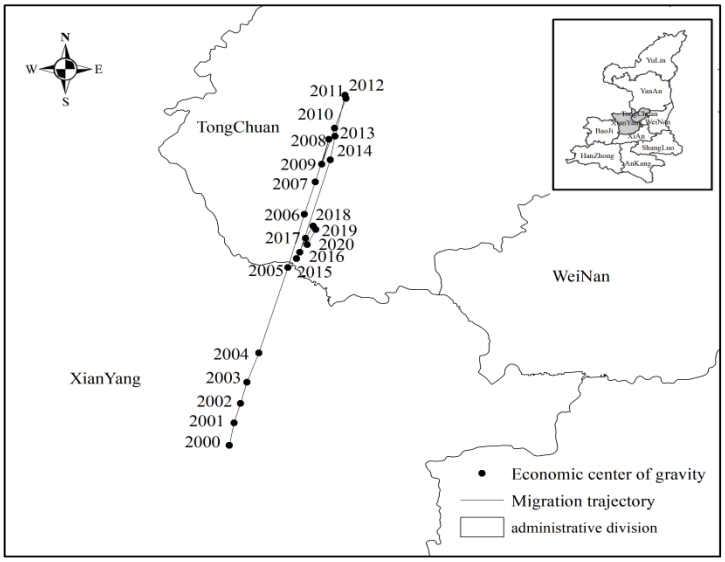

Figure 2. Migration trajectory of the economic gravitational center in Shaanxi Province

3.3. Evolution of the Industrial Gravity Centre in Space and Time

- Spatial-temporal evolution of the primary industry's gravitational center

Figure 3(a) illustrates the dynamic evolution of Shaanxi Province's key industry gravitational center. Since 2000, the center of gravity of primary industry in Shaanxi Province has changed to the northeast, with a deviation range of 108.69-108.77 degrees east longitude and 34.51-34.85 degrees north latitude. Since Jingyang County of Xianyang City in 2000, Liquan County of Xianyang City in 2002, and Chunhua County of Xianyang City in 2010, the geographical location has shifted. This indicates that the development of the primary industry in Shaanxi Province has not altered significantly over time.

From the standpoint of the center of gravity's moving distance and direction, its spatial dispersion can be classified into four stages. (1) From 2000 to 2002, this stage traveled 7.22 km to the northeast. (2) From 2003 to 2006, this stage shifted 11,26 km to the southwest. (3) From 2007 to 2014, this stage shifted 29.97 km to the northeast. (4) From 2015 to 2020, this stage migrated 0.41 km to the northwest over a somewhat narrow span.

Shaanxi Province's agriculture and aquaculture industries have gradually shifted toward northern Shaanxi, i.e., the industry's principal focus is in the northeast, as a result of the national government's ongoing policy shifts. The fundamental reasons for the evolution of the core industry's center of gravity exhibiting the aforementioned features are as follows: (1) The land resources of northern Shaanxi are abundant, and the agriculture and breeding industries are becoming increasingly concentrated. (2) The provincial government of Shaanxi actively promotes the strategic adjustment of the agricultural and rural economic structure.

Strengthen the input and development of agriculture, the fruit industry, and animal husbandry through the modification of industrial structure, economic structure, and agricultural variety structure, and develop other cash crops according to local requirements. (3) The province of Shaanxi increased the production of cash crops by bolstering high-standard farmland development, land consolidation, agricultural water conservation projects, and soil improvement, as well as other initiatives. (4) The infrastructure is imperfect, the development of agriculture is significantly influenced by natural causes, natural disasters have a large impact on agriculture, but their frequency is considerable, and there is unpredictability regarding time and location. There is no evident pattern in the frequency with which these circumstances cause the principal industry to shift its concentration.

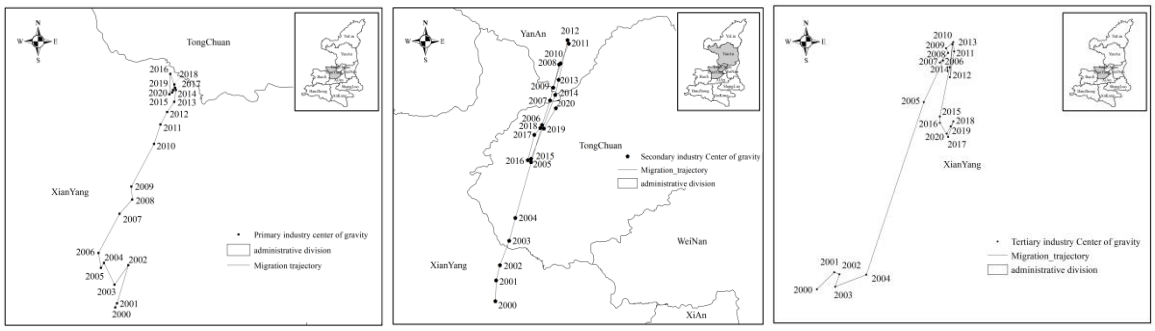

Figure 3. Migration trajectory of the industrial gravity centre

- Spatial-temporal evolution of the principal industry's gravitational center

Figure 3(b) illustrates the dynamic nature of the evolution of the secondary industry's gravitational center in Shaanxi Province. Since 2000, the center of gravity of primary industry in Shaanxi Province has changed to the northeast, with a deviation range of 108.66-108.90 degrees east longitude and 34.70-35.51 degrees north latitude. The center of gravity changed from Jingyang County of Xianyang City in 2000, to Chunhua County of Xianyang City in 2001, to Yaozhou District of Tongchuan in 2004, to Xunyi County of Xianyang City in 2007, to Huangling County of Yan'an City in 2012, to Xunyi County of Xianyang City in 2014, and to Yaozhou District of Tongchuan between 2015 and 2020.

From the standpoint of the center of gravity's moving distance and direction, its spatial distribution can be separated into two stages. (1) From 2000 to 2012, this stage traveled 109.05 km to the northeast. (2) From 2013 to 2015, this stage travelled 11.09 km to the southwest. Gradually decreasing movement distance and a relatively concentrated center of gravity. (3) From 2016 to 2020, it moved to the northeast, with a travel distance of 38.32 km.

The primary factors for the evolution of the secondary industry's center of gravity are as follows: The development of Shaanxi Province's primary industries is primarily centered in the province's northern region. In northern Shaanxi Province, Yulin City is the epicenter of the coal industry. Prior to the year 2000, coal exploration and development was increased, and the Shenmu coal base was also constructed. Pull the secondary industry's center of gravity directly to the north. With the expansion of oil and gas in Yan'an, the establishment

of the Yanchang oil base, and the acceleration of metal mining in Shangluo City, however, the secondary industry's center of gravity has shifted to the southwest. The industrialization level of each region has significantly increased, the secondary industry focus is relatively balanced and concentrated, but the mineral resources of the northern Shaanxi region are superior and provide a solid foundation for development, whereas the industrial development of southern Shaanxi is relatively lagging, resulting in a greater north-south development gap than east-west.

- Spatial-temporal evolution of the tertiary industry's gravitational center

Figure 3(c) illustrates the dynamic nature of the evolution of the Shaanxi Province tertiary industrial center of gravity. Since 2000, the center of gravity of tertiary industry in Shaanxi Province has changed generally to the northeast, with a deviation range of 108.68-108.79 east longitude and 34.50-34.69 north latitude, and the spatial position being Jingyang County, Xianyang City.

Based on the moving distance and direction of the center of gravity, its spatial dispersion can be split into three stages: (1) From 2000 to 2010, this stage traveled 27.26 km to the northeast at a relatively rapid rate. (2) From 2011 to 2012, this stage shifted 2.89 km to the southwest over a relatively limited span. (3) From 2013 to 2020, this stage migrated southwestward by 14.15 km.

The evolution track of the tertiary industry exhibits the aforementioned features primarily due to the fact that the development of the tertiary industry is accompanied by rapid economic expansion. The center of gravity of Shaanxi's GNP indicates a shift from the southwest to the northeast, as does the center of gravity of the tertiary industry. In recent years, the investment structure of the service industry in Shaanxi Province, which has a low urbanization rate, has been unreasonable, and the poor investment and low labor productivity of certain industries have hampered the development of the tertiary sector. Northern Shaanxi has maintained a high rate of development, and the process of industrialization has been accelerated, which promotes the rapid development of finance, information, trade, logistics, and other related industries in the region, resulting in the center of Shaanxi's tertiary industry gradually shifting to the northeast and converging. Nonetheless, the progress of industrialization and urbanization in southern Shaanxi is generally lagging, and industries such as banking and trade are underdeveloped, causing the regional disparities in the development of tertiary industry in Shaanxi to grow continuously.

In general, the tertiary industry expands swiftly alongside economic expansion. The gross product center of Shaanxi Province demonstrates a southwest-to-northeast trend, which is mirrored by the tertiary industry. The continuous acceleration of the development of the primary and secondary industries has facilitated the rapid development of finance, information, trade, transportation, logistics, and other related industries in Shaanxi Province, thereby widening regional disparities in the development of the tertiary industry in Shaanxi Province.

3.4. Coupling Analysis of the Population and Economic Gravitational Centers

The distance between the population and economic centers of gravity in Shaanxi Province increased gradually from 0.08 km in 2000 to 0.48 km in 2013. There are two stages to the change in distance between the population and economic centers of gravity. In the first stage (2000-2011), the distance between the population and economic centers of gravity in Shaanxi Province increased from 0.08 km in 2000 to 0.48 km in 2004. During the second stage (2012-2020), the distance between Shaanxi Province's population and economic centers of gravity was essentially maintained at 0.30 km. During this time period, the population and economic centers of gravity in Shaanxi Province moved rather consistently, and the distance between them stayed constant.

Table 1. Coupling analysis of the population and economic gravitational centers in Shaanxi Province

Year	Population center of gravity		Economic barycenter		Spatial distance
	East Longitude	North Latitude	East Longitude	North Latitude	
2000	108.752298	34.633781	108.677403	34.594695	0.08
2001	108.752545	34.635242	108.683995	34.628759	0.07
2002	108.753668	34.639715	108.692882	34.658203	0.06
2003	108.753154	34.637603	108.701883	34.690329	0.07
2004	108.753707	34.637908	108.718401	34.734718	0.1
2005	108.753316	34.636695	108.758771	34.864368	0.23
2006	108.753902	34.637149	108.781681	34.945055	0.31
2007	108.754012	34.639183	108.79705	34.994036	0.36
2008	108.754116	34.636105	108.815992	35.058789	0.43
2009	108.756215	34.641123	108.805934	35.020729	0.38
2010	108.75797	34.646465	108.823665	35.075401	0.43
2011	108.760254	34.650824	108.839832	35.12066	0.48
2012	108.76051	34.653328	108.838275	35.125626	0.48
2013	108.761393	34.653099	108.824639	35.063434	0.42
2014	108.76032	34.648209	108.817814	35.027594	0.38
2015	108.75882	34.651869	108.775379	34.88757	0.24
2016	108.761165	34.655675	108.770776	34.877906	0.22
2017	108.77007	34.645744	108.78346	34.90855	0.26
2018	108.768612	34.632323	108.793879	34.927002	0.3
2019	108.768054	34.637006	108.79768	34.921783	0.29
2020	108.777986	34.624345	108.785602	34.899021	0.27

As can be seen from Table 2, the demographic and economic centers of gravity in Shaanxi Province moved in different directions each year from 2000 to 2020. During the years 2000-2001, 2001-2002, 2003-2004, 2005-2006, 2006-2007, 2008-2009, 2009-2010, 2010-2011, 2013-2014, and 2015-2016, the Population center of gravity and the economic center of gravity essentially maintained the same direction of change. However, during the years 2002-2003, 2004-2005, 2007-2008, 2011-2012, 2014-2015, 2016-2017, 2017-2018, and 2018-2019, the two changes reversed course. In 2012-2013, 2019-2020 the spatial variability was 0.12 and 0.02, and the direction of the two shifts was essentially immaterial. In Shaanxi Province, the consistency of the change of population center of gravity and economic center of gravity was 0.78 from 2000 to 2020, suggesting that the direction of change between the two was extremely consistent.

Table 2. Consistency between Shaanxi Province's population and economic gravitational centers

Year	Population center of gravity		Economic barycenter		Change consistency
	ΔY(E)	ΔX(E)	ΔY(P)	ΔX(P)	C=COSθ
2000					
2001	0.0002	0.0015	0.0066	0.0635	1.00
2002	0.0011	0.0045	0.0089	0.0616	0.99
2003	-0.0005	-0.0021	0.009	0.0765	-0.99
2004	0.0006	0.0003	0.0165	0.1740	0.56
2005	-0.0004	-0.0012	0.0404	0.2103	-0.99
2006	0.0006	0.0005	0.0229	0.1297	0.74
2007	0.0001	0.0020	0.0154	0.1137	1.00
2008	0.0001	-0.0031	0.0189	0.0267	-0.80
2009	0.0021	0.005	-0.0101	0.0166	0.59
2010	0.0018	0.0053	0.0177	0.0999	0.99
2011	0.0023	0.0044	0.0162	0.0502	0.99
2012	0.0003	0.0025	-0.0016	-0.0572	-1.00
2013	0.0009	-0.0002	-0.0136	-0.098	0.12
2014	-0.0011	-0.0049	-0.0068	-0.1759	0.98
2015	-0.0015	0.0037	-0.0424	-0.1497	-0.79
2016	0.0023	0.0038	-0.0046	0.0210	0.72
2017	0.0089	-0.0099	0.0127	0.0491	-0.55
2018	-0.0015	-0.0134	0.0104	0.0132	-0.85
2019	-0.0006	0.0047	0.0038	-0.0052	-0.87
2020	-0.0009	-0.0181	0.0066	0.0184	0.29

In conclusion, following a period of growth, the distance between Shaanxi's population and economic centers of gravity has stayed largely steady. Not only did the direction of the population center of gravity and economic center of gravity remain the same for the most of the period from 2000 to 2020, but the overall direction of movement was also highly consistent.

4. Evolution of the Population, Economic and Industrial Gravitational Center: An Analysis of Affecting Elements

4.1. Economic Growth-Related Variables

The evolution of Shaanxi Province's economic center of gravity is strongly tied to the province's economic expansion. When the economy is expanding rapidly, the efficiency can be enhanced, but the two degrees of differentiation, the economic center of gravity shifts, and regional economic discrepancies grow. In addition, rapid economic growth reduces social poverty and raises resident income and employment; that is, the greater the economic growth rate, the less poverty, the higher the per capita GDP, and the smaller the regional economic disparities. The evolution of the economic center of gravity in Shaanxi Province is influenced by economic growth.

4.2. Economic Institutional Change Factors

The economic system is the introduction and execution of behavioral limitations into economic operations. Residents' mutual relationships and range of options are defined by

laws, property rights are safeguarded, transaction costs are decreased, the stability of the transaction environment is increased, and economic growth is robust. China is transitioning from a planned economy to a market-based economy, and the market mechanism is strengthening progressively. In a planned economy, economic progress is equalized, whereas in a market economy, regional division is exacerbated and economically developed regions become more economically developed. The evolution of the economic center of gravity is affected by the transformation of the economic system in Shaanxi.

4.3. Industrial Structure Factors

Industrial structure relates primarily to the economic relationship and quantity relationship between the three industries in the social production process. Industrial structure differs at different economic levels. Reasonable industrial structure is the foundation for regionally healthy and sustainable development. A reasonable industrial structure can facilitate coordination between the economic center of gravity and the demographic center of gravity, thereby decreasing regional economic disparities.

4.4. Factors Related to Urbanization

The evolution of the population center of gravity is influenced by the degree of urbanization and the proportional distribution of capital income. The greater the urbanization rate, the more people a city can handle, the more people migrate from economically depressed areas to economically prosperous cities, and the population center of gravity shifts. The share of distribution of capital income is connected. The overly high share of capital income distribution reduces the income of workers with low capital amounts who rely on labor, hence promoting a shift in the population's center of gravity.

4.5. Factors related to education

Public education is beneficial to raising the human capital of the work force, enhancing the income of the labor force, and decreasing the deviation between the population and economic centers of gravity, hence minimizing regional economic disparities. Due to an increase in education expenditures and an improvement in the penetration rate, the human capital pool of disadvantaged inhabitants has increased, hence promoting migration to economically developed regions. Additionally, the development of transportation, communications, and other infrastructure has aided the migration of underdeveloped inhabitants to developed regions.

5. Conclusions and Recommendations

5.1. Conclusions

This paper analyzes the spatial migration trajectory, moving distance, direction, spatial coupling, and related influencing factors of population center of gravity, economic center of gravity, and industrial center of gravity in Shaanxi Province from 2000 to 2020 using GIS, and draws the following conclusions: (1) Economic expansion, industrial development, and

demographic change in Shaanxi Province are interdependent and mutually beneficial. (2) From 2000 to 2012, Shaanxi Province's economic center of gravity, population center of gravity, and industrial center of gravity shifted northeastward. (3) After 2013, the economic and population centers of gravity shifted swiftly to the southwest, with the economic center of gravity migrating more quickly than the population center of gravity. (4) The degree of longitude correlation between the center of gravity of the primary industry and the center of gravity of the economy and population is the highest, while the secondary and tertiary industries are the primary cause of the economic development gap between the north and the south of Shaanxi Province and the tertiary industry has become the leading factor for the north-south population migration in Shaanxi Province. (5) Institutional change, industrial structure, urbanization, and public education influence Shaanxi's population, economy, and industrial concentration.

5.2. Recommendations

On the basis of the preceding findings, the following policy recommendations are made: First, we should encourage the merger of Xi'an and Xi'an and the economic development of Shaanxi Province through the expansion and reinforcement of the provincial capital. Second, actively support the southern Shaanxi region's adaptation to local conditions, develop an appropriate agriculture industry cluster, and propel the province's overall primary industry's high-quality, rapid expansion. Third, enhance the economic vitality of eastern Shaanxi by capitalizing on the distinctive assets of each county. Relevant industrial policies have been implemented to support Yulin, Yan'an, and Tongchuan, reduce backward production capacity, restructure their own economic development mode, delve deeper into tourism resources, and improve investment attractiveness for high-tech businesses. For Shaanxi Province's economic development to be coordinated, it is required to further apply industrial strategies to address the issue of uncoordinated regional development. Fifth, boost the rate of urbanization, encourage population mobility, expand public education, and enhance the level of human capital.

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The Economic Environment During the Covid-19 Pandemic from the Point of View of the Sustainability of Small and Medium-Sized Enterprises

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Abstract: Small and medium-sized enterprises (SMEs) are the pillar of the Slovak economy; they make up 99.9% of the total number of business entities. In the corporate economy, they provide 71.8% of job opportunities for the active workforce and 55.1% participate in the creation of added value. We conclude that they are an important pillar of the Slovak economy and therefore it is necessary to point out their sustainability not only during the pandemic but also after it. All the data with which we work are secondary quantitative data, which come mainly from the official statistics of the Slovak Business Agency and the Slovak Statistical Office. It is not a collection of data; for analysis, a combination and summary of data was required. The length of a time series or data period depends always on its availability, so the time of the selected indicator may be different (we mainly focus on the pandemic period – 2020 and 2021, if available). However, previous periods were mainly used to estimate indicators' development trends. The contribution will not only evaluate the sustainability of SMEs but in the conclusions will point out possible solutions in the future.

Keywords: small and medium enterprises; sustainability; innovations; COVID-19

JEL Classification: M21; O11

1. Introduction

Small and medium-sized enterprises (SMEs) are crucial to any country's economic acceleration. Their contributions (from a national economic point of view) are mainly based on their significant number, their adaptability, their flexibility in decision-making, and the resulting synergistic effect. There are many SMEs, much more than big enterprises. When taken into consideration, one small enterprise does not have a huge benefit to the economy, but many small enterprises have substantial benefits to the economy. (Carvalho & Costa, 2014; Gregova & Novikov, 2017; Haviernikova & Mynarzova, 2018).

In the long term, SMEs contribute significantly to total employment and economic growth. The importance of small and medium-sized enterprises can also be seen in the structure of economically active enterprises. During the monitoring period, COVID-19 pandemics were central to the economic environment. In general, the economic recession and its activity were observed not only in Slovakia but also in other countries. The overall performance of the European Union is weakened mainly by the collapse of the main economies. The impact of COVID-19 also reflects the economic performance of small and

medium enterprises. The unfavorable economic situation in Slovakia affected the SMEs' development of the monitored economic indicators. (SBA, 2021)

Businesses in SMEs around the world have recently been affected, especially by the COVID-19 pandemic. The impact of the pandemic has manifested mainly in the areas of economic, social, health, and technology at the national and global levels. The COVID-19 pandemic affected all economic units in the general classification of households, businesses, and states in terms of their behavior and decision-making. The pandemic is considered a systemic shock with profound consequences in the short, medium, and long term. (Engidaw, 2022).

The COVID-19 pandemic began in Slovakia in March 2020. Adopted anti-pandemic measures contributed to strong economic decline and unemployment. Other economic variables such as economic growth, public spending, production, household consumption, investment, and sales were significantly affected by the pandemic (Khan et al., 2021). Government regulations and changes in consumer preferences caused depression in the business environment (Kramarova et al., 2022; Martin & Roman, 2021; Ugurlu & Jindrichovska, 2022). Despite the stringent measures taken by the countries, it has had a negative impact on the economies of all countries. This is due to the interconnection of current economies, so external environmental developments have a significant impact on one country or another. (Caplanova, 2021). In general, the strictness, duration, and nature of the COVID-19 anti-pandemic measures around the world were relatively heterogeneous.

In the future, small and medium enterprises will become the most important catalysts for economic growth (Henderson & Weiler, 2010). In Slovakia, SMEs account for more than 99% of all long-term enterprises, including the three-year analysis period (2019-2021). (Slovak Business Agency, 2022). For example, by 2021, small and medium-sized enterprises provide employment opportunities in the corporate economy to nearly 3/4 of the active workforce (74%) and contribute to more than half of the creation of additional value (55%).

In Slovakia, 94% of small and medium-sized enterprises experienced sales declines during the first and second wave of the epidemic. If we want to highlight the problems of large companies as a result of the crisis in Slovakia, the Slovakian automotive industry has been severely affected, particularly during the first wave of the epidemic. The automotive industry, as well as other representative sectors, is generally a typical representative of the globalization sector and is still struggling to meet demand in the COVID-19 crisis. All four Slovakian car manufacturers (Volkswagen, Peugeot, Kia, Jaguar Land Lover) closed production in March 2020. This has led to most automotive suppliers in Slovakia reducing production significantly or closing down their operations due to a lack of automotive components (Slovak Business Agency, 2022).

2. Methodology

The main purpose of this paper is to evaluate the state of SMEs and their development during the pandemic COVID-19 in Slovakia. This was realized in the paper by examining historical data on the composition, legal form, and industry of SME businesses. The first feasible step in the research was the detailed acquisition and study of basic theoretical knowledge from the literature to create an analysis of the state of SMEs in Slovakia.

Subsequently, by organizing the data based on time series, we processed the data into graphs and tables, the results of which are presented in the paper. All the data we used were secondary quantitative data mainly from Slovak Business Agency reports and official statistics of the Slovak Statistical Office. The Slovak Business Agency performs regular monitoring and research of the business environment in Slovakia, focusing mainly on the SME sector.

A small and medium enterprise is defined in the European Commission report no. 2003/361/Es and European Commission Regulation No. 651/2014 as any entity engaged in economic activity, irrespective of its legal form. Based on this definition, it can include also self-employers, free professions, and self-employed farmers. For legal entity to be categorized as an SME, it must meet these criteria:

- number of employees fewer than 250 persons,
- annual turnover not exceeding 50 million euros,
- annual balance sheet total not exceeding 43 million euros.

The main criterion is the number of employees. Then the enterprise is an SME if it meets the annual turnover and/or the annual balance sheet limit.

3. Results

The dynamic development of SMEs is one of the basic prerequisites for the healthy development of the country. During the pandemic, the Slovak economy recorded a drop in GDP, as did other countries. Of course, this was also reflected in the SME sector, where as a result of anti-pandemic measures, the growth in the number of SMEs stopped. COVID-19 interrupted the growth of all important economic indicators of SMEs. Despite the measures, many SMEs were unable to maintain jobs or employment. This decrease occurred in 2020 for the first time since 2014 when it recorded an annual increase. Slovak companies' competitiveness depends mainly on the environment they develop their activities. Changes in the business environment also reflect changes in the number of business sectors over time.

3.1. Evaluation of the State of the SMEs Sector During the Pandemic Crisis

The impact of coronavirus pandemic had a negative impact on the creation of new SMEs in Slovakia during 2020. According to data processed from the Register of Organizations of the Statistical Office of the Slovak Republic, in 2020 the trend of year-on-year increase in the number of established entrepreneurs stopped, in a year-on-year comparison, the number of established SMEs decreased by 2%. The effects of the crisis were also reflected in the decline of other forms of business, as shown in Table 1.

The annual increase of SMEs in the pre-crisis period was influenced by several factors, the most important of which was the reduction of the tax burden, the increase of flat-rate expenses of self-employed persons from 40% to 60% of the total income, and other significant changes, such as the reduction of the income tax rate from 21% to 15% for legal entities and self-employed persons with annual income of up to EUR 100,000, an increase in the nontaxable part of the tax base or a further increase in the deduction of research and

development expenses came into force at the beginning of 2020. In the case of SMEs – legal entities, a positive change was the cancellation of tax licenses that came into force at the beginning of 2018. In addition to the factors mentioned above, the growth in the number of new SMEs was also accompanied by the positive development of the global economy or the growth of domestic and foreign demand. However, another development, which is mainly influenced by the corona crisis, was questionable. In Slovakia, the SME environment has long been characterized as unsatisfactory and deteriorated for the business of the most vulnerable groups of entrepreneurs, such as self-employers and microenterprises.

Table 1. Development of the number of established SMEs according to legal forms for the years 2018-2021 (SBA, 2022)

Legal form	2018	2019	2020	Index 2019/2020	2021	Index 2020/2021
Legal entity	22,626	25,139	22,740	90.5 (decrease)	19,771	86.9 (decrease)
Self-employed	50,938	54,225	54,592	100.7 (increase)	67,528	123.7
Self-employed farmers	490	230	310	134.8 (increase)	250	80.6
Free professions	4,021	5,289	5,532	104.6 (increase)	4,989	90.2
Total	78,075	84,883	83,174	98.0 (decrease)	92,538	111.3

3.2. The Impact of the Corona Crisis on the Development and Functioning of SMEs

The corona crisis brought interesting findings, mainly that the interest in starting a business decreased mainly in the industrial sectors, which represented a year-on-year decrease of 12.3%, and services, where this decrease was by 7.7%. The following Table 2 also indicates interesting impacts.

Table 2. Development of the number of established SMEs by industry based on data from the Slovak Registry of Social Affairs in 2018-2020 (SBA, 2022)

Industry	2018	2019	2020	Index 2019/2020	2021	Index 2020/2021
Agriculture	3,097	3,033	2,925	96.4 (decrease)	2,945	100.7 (increase)
Industry	11,687	11,913	10,452	87.7 (decrease)	11,152	106.7 (increase)
Construction	18,262	20,757	20,524	98.9 (decrease)	25,188	122.7 (increase)
Commerce	6,100	6,689	7,218	107.9 (increase)	7,836	108.6 (increase)
Transporting and information	7,672	8,343	8,410	100.7 (increase)	9,744	115.9 (increase)
Accommodation and food service activities	2,145	2,517	2,467	98.0 (decrease)	1,856	75.2 (increase)
Business services	23,618	25,599	25,613	100.1 (increase)	28,891	112.8 (increase)
Other services	5,494	6,026	5,565	92.3 (decrease)	4,926	88.5 (decrease)
Total	78,075	84,883	83,174	98.0 (decrease)	92,538	111.3 (increase)

As can be seen in Table 2, it seems that the corona crisis was also an opportunity because the sudden change in the functioning of the company created space for innovation and the emergence of a new generation of entrepreneurs. New business opportunities were able to be used by budding entrepreneurs mainly in sectors such as transport and information, mainly due to the rapid development in the field of courier services, warehousing, and auxiliary activities in transport. The number of new SMEs in commerce also increased by 7.9%, contributed by retail outside stores, including the online store. According to statistics, one third more new companies were created in the fourth quarter of 2020 than in the same period of 2019. This development creates a decent prerequisite for the recovery of the SME

sector, which can become even more competitive and resistant to similar crises in the future through transformation. A similar development was also recorded in other European countries, such as France and Great Britain.

At the end of 2021, almost one-third (29.9%) of the total number of active small and medium enterprises were less than 3 years old. The share of established SMEs that have been operating on the market for 4 to 10 years since their establishment also represented almost one third (31.8%). 38.3% of active SMEs have been operating in Slovakia for more than 10 years. 14.3% of small and medium companies that have been operating on the market for more than 20 years are also a stable part of the business environment in Slovakia. This structure is also shown in Figure 1.

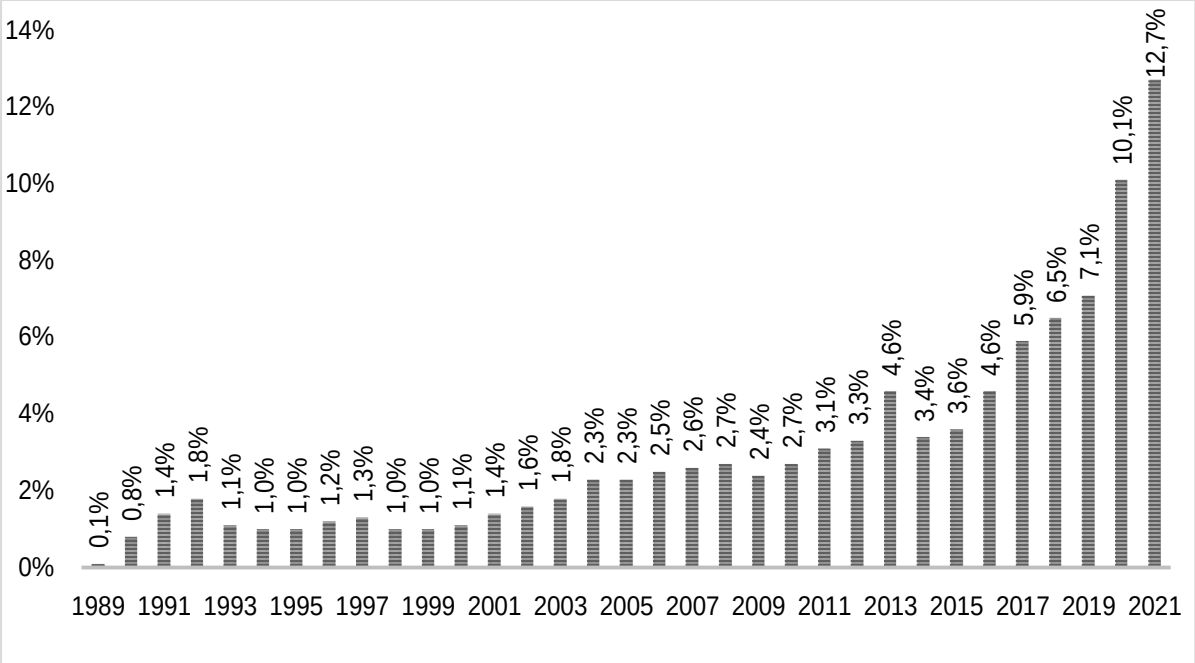

Fig.1: Structure of SMEs by date of establishment (SBA, 2022)

Despite the threat of COVID-19, which brought with it great threats in the form of closed operations and limited business opportunities, SMEs in Slovakia tried and are trying to deal with the given situation. During 2020, 47,648 business entities closed their business, which represents 5.4% of all registered entities in Slovakia. The highest percentage was self-employed, up to 82.1%. Other operating entities did not experience such a large decrease.

In a year-on-year comparison (2019/2020), the number of total defunct business entities paradoxically decreased by 15.1%. According to these data, the number of defunct of enterprises in 2020 Slovakia exceeded expectations. In 2020, the fewest enterprises closed their operations in the past decade. The most significant decrease in the number of demises occurred in the case of independent professions, year-on-year by almost a third (32.1%). This is followed by self-employed people with a decrease of 14.5% and self-employed farmers, where a year-on-year decrease of 7.3% was recorded. In 2020, the defunct of enterprises – legal entities developed without significant change. In addition to the negative impacts, we can state that the measures taken by the state also brought positive results in the form of the

implementation of support measures. The main goal was to maintain all existing business entities, even though many would have disappeared anyway in a normal situation.

The sectoral structure of defunct business entities reflects the overall sectoral structure of SMEs in Slovakia. Of all defunct business entities in 2020, most of them (25.7%) operated in the business services sector. This is followed by companies in the construction industry (23.8%) and in trade (15.5%). Only 2.7% of the closed companies were engaged in accommodation and food services and 4.7% in agriculture (SBA, 2022).

In 2021, the number of demised business entities increased to 51,724, which represents an annual increase of 8.6%. Legal entities had the greatest impact on growth, where the increase compared to 2020 was 133.2%, representing the most defunct companies in the last ten years. The number of defunct SMEs decreased by 5.8% year-on-year. Detailed data are shown in Table 3.

Table 3. The number of defunct business entities based on legal forms (SBA, 2022)

Legal form	2018	2019	2020	2021	Index 2021/2020
Legal entity	5,442	4,497	4,467	10,419	233.2 (increase)
Self-employed	41,417	45,754	39,132	36,856	94.2 (decrease)
Self-employed farmers	453	328	304	285	93.8 (decrease)
Free professions	4,856	5,518	3,745	4,164	111.2 (increase)
Total	52,168	56,097	47,648	51,724	108.6 (increase)

4. Discussion

A basic prerequisite for the development of SMEs is a high-quality business environment. Just like other areas of social life in Slovakia, the business environment has undergone fundamental changes over the past 20 years. Slovakia's problem is the long-term absence of a systemic approach aimed at continuously improving business conditions. After joining the EU, Slovakia dynamically approached the economic level of the original EU members. Unfortunately, this process has slowed down significantly in recent years, or we can talk about stopping the catch-up of the most developed countries of Western Europe. Since the end of the financial and economic crisis, small and medium-sized enterprises in Slovakia have benefited mainly from advancing globalization, changes in economic policies, and the rapid development of the world economy.

Due to the different natural, economic, and social conditions, or historical contexts, the conditions for doing business also differ in individual regions of Slovakia. Ultimately, they contribute to the uneven development of regions, including small and medium-sized businesses. If we were to focus in more detail on the evaluation of selected quantitative indicators of SMEs at the level of individual regions and districts of Slovakia, we must state that the highest concentration of SMEs is in the territory of the Bratislava region. In 2020, approximately one in five active small and medium enterprises (22.7%) had their headquarters in this region. It is followed by the Žilina Region, where 13.5% of all active SMEs are located, and the Prešov Region with 13.0%. In the other regions, the representation of SMEs is more even. The smallest, only 9.3%, of SMEs were registered in the Trenčín region.

In connection with the corona crisis, the number of active SMEs decreased year-on-year in most regions. The most significant decrease occurred in the Banska Bystrica region by 2.8% and the Trenčín region by 1.5%. The specificity of the Bratislava region is the persistent increase in the number of SMEs even during the corona crisis. Compared to the precrisis year 2019, the number of SMEs in the region increased by 3.7%, indicating that entrepreneurs are constantly finding enough opportunities in the region and suitable conditions for the implementation of new business activities. The higher resistance of business entities based in the Bratislava region to adverse conditions is also confirmed by the development during the previous global financial and economic crisis when their number also increased (SBA, 2022).

5. Conclusions

The development and operation of SMEs in Slovakia have been affected by the corona crisis in the same way as in all surrounding countries. Many of them survived and are trying to continue their activities. The current situation related to the energy crisis and the spread of the coronavirus in Slovakia in recent years is a burdensome test for all. Entrepreneurs in the category of SMEs will feel the impacts the most. As already mentioned, SMEs are the pillar of the Slovak economy, they make up 99.9% of the total number of business entities, provide job opportunities in the corporate economy for almost 75% of the active workforce, and participate in more than 50% of gross production and creation of added value. However, it will be questionable how they will function when not only the corona crisis, the energy crisis, and high inflation cause problems for the survival of operating entities.

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Conflict of interest: none.

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Assessing the Existence of Corporate Shared Value in Companies Based on CSR Reports

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Abstract: Rising customer demands, growing pressure from legislation, and the expectations of stakeholders motivate companies to adopt corporate social responsibility (CSR). For companies that want to build their reputation, remain competitive, and gain customer and employee loyalty, socially responsible behavior is essential. A successful company is one that focuses on making financial profits while also contributing, both in the form of concern for natural conditions and the welfare of the community. CSR activities do not necessarily coincide with the area in which the company does business. However, improvement activities can be approached systematically and purposefully based on the activities of the company. This is the case of creating corporate shared value (CSV). A gap in the literature for scientific research was found after the evaluation of earlier works. Indicators and a clear approach are still lacking to determine if the company is producing CSV or just CSR. The aim of this paper is to identify key indicators of CSV and to evaluate them through the CSR reports of companies. Ten multinational companies have been selected and examined. A benchmarking-scoring technique based on several defined qualitative and quantitative indicators was used for assessment to provide a view of compliance with CSV principles.

Keywords: corporate shared value; CSV; corporate social responsibility; Global Reporting Initiative; CSR reports

JEL Classification: M14; L21

1. Introduction

Businesses, especially large ones, can influence the environment and the society in which they do business. They can implement changes that contribute to a change in the perception of society. Corporations must adopt CSR strategies to establish a business committed to society and vulnerable groups. The most important is to focus on those that are closest to them, the local areas in the country of the companies' origin or areas in which companies operate and have great presence. Achieving an equilibrium of profit and the common good is a more adequate strategy for survival in the long term. (He & Harris, 2020; Brammer et al., 2020)

Corporate Social Responsibility (CSR) is an area that has grown in the last three decades and has gained support through several real-world examples to the extent that CSR is considered one of the strong catalyst factors for sustainable development (Idowu & Leal Filho, 2009). CSR can be broadly defined as "a self-regulating business model that helps a company be socially accountable to itself, its stakeholders, and the public" (Wan et al., 2020). Berger-Walliser and Scott (2018) propose a more explicit definition of CSR in the age of

globalization, arguing that corporate social responsibility, which is controlled by a company or the state, includes activities that internalize the costs of externalities arising directly or indirectly from business activities and processes that take into account and address the impact of business activities on the affected stakeholders.

The concept of corporate shared value was first introduced by Porter and Kramer (2011). Creating shared value is a way to reconnect business with society by identifying and expanding the links between social and economic progress. This requires the enterprise to recognize societal needs not only as a burden on the business (increasing costs) but to improve business performance while creating shared value for society as well. This approach implies a change in the perception of business, as it considers society and the environment not only as the external environment in which the business operates but also as an integral part of the business (Lapina et al., 2012). Salonen and Camilleri (2020) define CSV as a concept that brings business and society together so that the business makes a profit while raising the standard of living in the local community. Folk (2021) state that CSV is a next-generation business mindset that strengthens a company's competitive position while favoring the company's operating environment. Bockstete et al. (2012) state that CSV is about "incorporating social issues into its core business strategies to create benefits for society while strengthening its long-term competitiveness". The areas of shared value creation can be divided into external and internal environments. Lapina et al. (2012) define internal areas of shared value creation: staff, technology, and working environment and external areas of shared value creation: environmental impact, economic benefits, and social benefits. The individual elements of the CSV of both the external and internal environment also appear as reporting topics according to Global Reporting Initiative (GRI) standards.

There is no clear methodology of evaluation whether a business is creating shared value. It is not currently precisely defined what indicators signal that shared value is being created in the company. The aim of this paper is to identify key indicators of shared value creation and to find them through the CSR reports of companies. Ten multinational companies have been selected and examined for their shared value creation. Large companies were chosen as there seems to be a difference in how companies tackle sustainability according to their size. Most large companies already have long-term sustainability initiatives in place. For small and

Table 1. List of selected companies for CSR analysis. Based on (RepTrak, 2021) and (Statista, 2022).

Company	Residency	Total revenue (billion US $)	Number of employees	Ranking in rating
Apple Inc.	Cupertino USA	365.2	154,000	46
Canon Inc.	Tokyo, Japan	32.0	184,034	6
Dell Inc.	Round Rock, USA	94.2	130,000	72
Intel Corp.	Santa Clara, USA	79.0	121,100	16
LG Group	Soul, South Korea	63.2	75,000	67
Nintendo	Kyoto, Japan	16.0	6,574	21
Panasonic Corp.	Kadoma, Japan	73.0	244,000	58
Samsung	Soul, South Korea	232.0	267,937	17
Siemens	Berlin, Germany	70.0	303,000	70
Sony Corp.	Minato, Japan	84.6	111,700	9

medium enterprises, the full adoption of certifications and conformance to regulations is rather a burden than an opportunity, as shown in previous studies (Reyes-Rodríguez et al., 2014).

To analyze CSR approaches and the principles of CSV, ten multinational companies operating in the field of electronics or electronic components are selected and summarized in Table 1. The basic overview includes the name of the company, its headquarters, total revenue in billions of US dollars for 2021, the number of employees, and the company's ranking in the global reputation assessment. Ranking in the rating is based on data from "The 2021 Global RepTrak 100" (RepTrak, 2021). Other data are from Statista (Statista, 2022).

2. Methodology

The methodological framework defined by Tsalis et al. (2020) was modified and used to define and assess the CSV of selected companies. The CSR analysis assesses whether enterprises listed in Table 1 create shared value. CSR reports of companies in two consecutive years 2020 and 2021 were researched and examined. CSR reports provide valuable both financial and non-financial information about corporate profiles and are the relevant source for this type of analysis.

We used benchmarking and evaluated CSR reports with the aim to search for information based on that we can confirm that the company is producing CSV. Then analytical section is based on the ten cornerstones of creating shared value. Ten quantitative and qualitative indicators were defined as the basis for deciding whether a company performs CSV. Theoretically, content analysis can be used to examine qualitative and quantitative indicators. However, this is often a subjective evaluation of the decision-maker and focuses on the amount (quantity) of published information but does not consider the meaning (quality) of the reported information (Guthrie & Abeysekera, 2006). Other method that can be used for analysis is scoring. The benchmarking-scoring technique was chosen in this work as it provides greater objectivity, a clearer summary, and an evaluation of findings. There are numerous studies describing the positives of benchmarking, e.g., Jetmarová (2011) presents benefits of benchmarking. Zemanová (2015) presents a survey analyzing the use of benchmarking, evolution, typology, and trends of benchmarking. Tsalis et al. (2020) used benchmarking-scoring to evaluate environmental profiles based on data published in CSR reports. In this work, their methodology is modified so that it is possible to assess the principles of CSV in the same style as in the case of assessing environmental profiles. The modified methodology based on Tsalis et al. (2020) is divided into three phases:

1. Phase: Selection of appropriate shared value indicators. Part of this step is creating a grading system to assess the data and information presented in CSR reports. The recommended scoring system is used to track the development of corporate performance as well as the degree of corporate responsibility. Indicators AI (Accountability index) and PI (Performance Index) are defined.
2. Phase: Evaluation of sustainability reports using following indicators: TAI (Total Accountability Index), TPI (Total Performance Index), ACI (Accountability Completeness Index), PCI (Performance Completeness Index).
3. Phase: Assessment of corporate environmental profile. Following indicators are used: CRI (Corporate Reporting Indicator), CPI (Corporate Performance Indicator), CMI (Corporate Management Indicator), TCPI (Total Corporate Profile Indicator).

2.1. The First Phase of Benchmarking-Scoring

Based on (Tsalis et al., 2020) in the first stage, the criteria to be investigated must be defined and specified. These criteria correspond to the ten cornerstones of shared value creation, which reflect the exact process of shared value creation and can thus be considered a suitable indicator. The last building block is communication through CSR report, in this case, the requirement is set for CSR report according to GRI standards, as compliance with the standards increases the clarity of the reports. Thus, a total of 10 elements are examined. The individual elements can also be seen in Table 1. The indicators are divided into two categories according to type, qualitative indicators, and quantitative indicators.

Table 2. Identified qualitative and quantitative indicators of shared value

Type 1: 2 indicators	Type 2: 8 indicators
Measuring the progress of key indicators	Senior management involvement – defining the vision
Learning from measurement – increasing effort	Identification of key topics
	Setting specific ambitious targets
	Using company resources to solve problems
	Efforts across the enterprise
	Cooperation with partners
	Focusing on important issues
	CSR report according to GRI

A scoring system is defined in the first phase. This is set up to analyze information about the individual CSV elements in the CSR reports. The proposed system consists of two parts that incorporate simple and easy-to-use indices. One of these indices is the AI (Accountability index). It assesses the quality of information for each selected shared value indicator.

Table 2 shows the scoring scale. The scoring scale is set on a scale of 0 to 3, assessing 4 levels in relation to the information disclosed within the report. Since many companies do not use comprehensive standards for how they report (GRI standards as one of the indicators) and thus use individual approaches to reporting, it is more difficult to examine this information. Type 2 indicator values cannot get 3 points.

Table 3. Scoring scale for the Accountability Index (AI). Own processing based on Tsalis (2020).

Quality Levels	Points	Descriptions
Level A	0	Information is not provided for monitored indicator
Level B	1	Qualitative information is provided for monitored indicator
Level C	2	Quantitative information is provided for monitored indicator
Level D	3	Information is clear indication of the progress of corporate performance for monitored indicator

Furthermore, the PI index (Performance Index) which evaluates the progress of business performance in the examined indicators is calculated. This index can be used to evaluate the quantitative information that demonstrates the progress of each indicator. The PI index and its scoring scale are shown in Table 4. In the case of the Performance Index, the scale is set from 0 to 2 points.

Table 4. Scoring scale for the Performance Index (PI). Own processing based on Tsalis (2020).

Points	Descriptions
0	The performance of the indicator is worse than the previous year
1	The performance of the indicator is same as the previous year
2	The performance of the indicator is better than the previous year

2.2. The Second Phase of Benchmarking-Scoring

Also, the second phase is based on the methodology of (Tsalis et al., 2020). In the second phase, the indexes that are used to evaluate the messages need to be set up. Based on the scoring system, four composite indices are thus set. According to Singh et al. (2007, p. 565-588), it is very useful to create composite indices that measure the overall performance score to meet the principle of comparability. As a result, the following indices are also proposed. The first composite index is the Total Accountability Index (TAI), or Total Accountability Index. This index assesses the overall quality of reporting among companies of the same, but also, from other industries. The TAI is calculated as the sum of the AI scores assigned to all indicators (from Table 1). The following formula illustrates the calculation of the TAI:

$$TAI = \sum_{i=1}^{2} AI_{type1} + \sum_{j=2}^{8} AI_{type2} \quad (1)$$

where *i* is the number of quantitative indicators and *j* is the number of qualitative indicators.

The TAI score is a number between 0 and 22. This is so that type 2 indications cannot be accessed through level D as this type of indicators can only provide one type of information – either quantitative or qualitative. The maximum number of points obtained is therefore 22 (2 indicators, with a maximum score of 3 points, and 8 indicators, with a maximum score of 2 points). Values that are close to the highest number show that the CSR report discloses data and offers good quality information for the majority of the chosen indicators of shared value creation.

Similarly, the Total Performance Index (TPI) is selected. This indicates the total number of the PI scores for each quantitative indicator (in Table 4). The highest TPI score can be 4 points (2 indicators, with a maximum score of 2). This phenomenon occurs if the enterprise has improved its performance in all the indicators examined.

$$TPI = \sum_{i=1}^{2} PI_{type1} \quad (2)$$

where *i* expresses the number of indicators, in this case, type 1. However, Searcy (2011) notes that the findings might not give a real picture of business performance because of the aggregating processes. For this reason, two other indices are also used: the Accountability Completeness Index (ACI) and the Performance Completeness Index (PCI). The ACI index examines the total number of indicators that appear in a CSR report (maximum 10), while the PCI index examines the number of quantitative indicators (maximum 2) (Tsalis, et al., 2020).

2.3. The Third Phase of Benchmarking-Scoring

According to van Staden et al. (2007), three types of information are relevant for the purpose of assessing the corporate profile. The following key perspectives are chosen for the scope of this paper: quality of reporting, quality of corporate management practices, quality of performance, and overall corporate profile.

The Corporate Reporting Indicator (CRI), assesses the practices of information disclosure. In the case of this work, it indicates the report within which the elements of shared value creation can be sought. For this reason, the CRI uses the TAI, and ACI indices – the TAI is used to assess the quality of information disclosed in CSR reports, and the ACI assesses the extent of disclosure practices.

$$CRI = \frac{1}{2} \times \left(\frac{TAI}{TAI_{max}} + \frac{ACI}{ACI_{max}} \right) \quad (3)$$

The second indicator is the Corporate Performance Indicator (CPI), which is defined as the overall progress of a company's TPI profile relative to the actual number of PCI performance indicators.

$$CPI = \frac{1}{2} \times \left(\frac{TPI}{TPI_{max}} + \frac{PCI}{PCI_{max}} \right) \quad (4)$$

The third indicator is the Corporate Management Indicator (CMI), which assesses the management approach and policies implemented by the company as part of its approach to creating shared value. For this reason, the CMI is based on the CPI, which assesses the performance of strategies, and on the ACI, which provides an indication of management practices.

$$CMI = \frac{1}{2} \times \left(CPI + \frac{ACI}{ACI_{max}} \right) \quad (5)$$

The last indicator is the Total Corporate Profile Indicator (TCPRI), which is the result of the average of the scores of the three indicators mentioned above (CRI, CPI and CMI). Each of the previous indicators highlights a specific perspective, whereas the TCPRI provides an overall assessment of the company profile. All indicators can take values <0;1>. A value of 0.5 is defined as the threshold value for all company profile indicators.

The formulas for calculating the indicators are given below.

$$TCPRI = \frac{1}{3} \times (CRI + CPI + CMI) \quad (6)$$

3. Results

First, authors analyzed information from CSR reports of each company and calculated AI and PI. Below we present results for Siemens company as an example. The AI indicator is calculated based on two different types of indicators stated in Table 2. Scoring scale from Table 3 was used. There is AI for Siemens calculated in Table 5. PI indicator is calculated for quantitative type 1 indicators. The results are shown in Table 6. Secondly, there were calculated four indexes based on previous calculations. The results are presented in Table 7.

Table 5. Calculation of Accountability Index (AI) for Siemens

Accountability Index (AI) for type 1 indicators		Accountability Index (AI) for type 2 indicators	
Measuring the progress of key indicators	3	Senior management involvement - defining the vision	2
Learning from measurement - increasing effort	3	Identification of key topics	2
		Setting specific ambitious targets	1
		Using company resources to solve problems	2
		Efforts across the enterprise	2
		Cooperation with partners	2
		Focusing on important issues	2
		CSR report according to GRI	2
Total	6		15

Table 6. Calculation of Performance Index (PI) for Siemens

Performance Index (PI) for type 1 indicators	
Measuring the progress of key indicators	1
Learning from measurement – increasing effort	2
Total	3

Table 7. Evaluation of indicators (TAI, TPI, ACI, PCI)

Company	TAI	TPI	ACI	PCI
Apple Inc.	17	3	9	2
Canon Inc.	18	3	9	2
Dell Inc.	14	3	8	2
Intel Corp.	14	2	9	2
LG Group	18	3	10	2
Nintendo	3	2	2	0
Panasonic Corp.	10	2	7	2
Samsung	19	3	10	2
Siemens	21	3	10	2
Sony Corp.	20	3	10	2
Average score	15.4	2.7	8.4	1.8
Min. score	3	2	2	0
Max. score	21	3	10	2

The Total Accountability Index projects the overall responsibility index score for the company according to the first and second type of shared value indicators. The second column examines the Total Performance Index, which examines the scoring of performance index scores. The third column is the Accountability Completeness Index, which measures the number of total indicators found. Then, in the last column is the Performance Completeness Index, which determines the number of performance indicators. The last three rows reflect the average score, determining the maximum and minimum scores.

Siemens received the best composite index score. It scored 21 points on the TAI, which was the deciding factor. In the other 3 indices, the scores of 3 other companies are identical (LG Group, Samsung, Sony Corp.). From these composite indices, it can be concluded that through the CSR report, Siemens provides all the information examined regarding the creation of shared value (ACI and PCI indicators), which is also the case for LG Group,

Samsung, Sony Corp. Within this analysis, the TPI and PCI performance indices may give somewhat biased data since only two indicators that are quantitatively measurable were selected. Examining a larger number of quantitative performance indicators would result in greater differences between the companies examined. Compared to Siemens, Nintendo was the worst placed company. It was the worst performer in all the indices examined, except for the TPI. While the other companies reported between 120 and 200 pages in CSR reports, Nintendo's document has 18 pages. It is not surprising that a lot of shared value indicators were not found in the report, hence it received a lot of 0 values. The resulting measured values correspond to the values in Table 7.

The next part of the research examines the CRI, CPI, CMI, and the overall TCPRI company profile indicator, which is the objective of this methodology. As a result, it is then possible to determine whether individual companies use the concept of shared value creation. Furthermore, it is possible to determine which elements need to be improved. A threshold of 0.5 is set for all these indicators. This threshold divides the interval in exactly half. On this basis, it is possible to determine the results for the overall corporate portfolio indicator and to decide whether shared value is being created.

The examined indicators take values of rational numbers in the interval <0;1>. The threshold value of 0.5 determines whether the enterprise uses the concept of shared value creation. The CRI indicator assesses corporate reporting practices. In this case, Nintendo has a completely inadequate level of communication (0.168). However, Panasonic Corp. is also close to the threshold value (0.577), so there is much room for improvement in the case of the reporting of these two companies. Another CPI indicator assesses the overall performance of the company. Performance is measured in this paper using two indicators. Hence, the frequent occurrence of some values is noticeable. It was assessed whether the enterprise measures its key indicators (and their expression) and then whether there is a shift and increase in effort. In this respect, the results are very promising. However, this is also because there are only 2 of these input indicators. It was also evident for most companies that they have had a coherent CSR reporting method for quite some time, hence there was hardly any assessment of improvement from last year. The third indicator in the ranking is the CMI indicator, which examines the management approach and policies of the company. In this indicator, the values achieved were high. The average value was 0.814, the highest average value achieved of the four indicators. This indicator also examined whether there is compliance with GRI standards. According to the results, 6 of the companies surveyed comply with the standards. Dell, Intel, LG, Samsung, Siemens, Sony. On the other hand, Apple, Canon, Nintendo, and Panasonic do not comply with the standards.

The last and crucial indicator of this paper is the TCPI overall corporate profile indicator. The value of this indicator determines whether the enterprise creates shared value. The average value is 0.790, with 4 of the 10 sample companies achieving a value higher than 0.9. None of the companies studied achieved the maximum score. However, companies scoring above 0.9 score very well. The threshold value (0.5) determines whether a company creates shared value. In the sample, all companies met this threshold except Nintendo with a total TCPI = 0.214. The highest values were obtained by the German company Siemens, with a

Table 8. Ranking of companies by overall profile score

Company	CRI	CPI	CMI	TCPI
Siemens	0.977	0.875	0.938	0.930
Sony Corp.	0.955	0.875	0.938	0.922
Samsung	0.932	0.875	0.938	0.915
LG Group	0.909	0.875	0.938	0.907
Canon Inc.	0.859	0.875	0.888	0.874
Apple Inc.	0.836	0.875	0.888	0.866
Dell Inc.	0.718	0.875	0.838	0.810
Intel Corp.	0.768	0.750	0.825	0.781
Panasonic Corp.	0.577	0.750	0.725	0.684
Nintendo	0.168	0.250	0.225	0.214
Average score	15.4	2.7	8.4	1.8
Min. score	3	2	2	0
Max. score	21	3	10	2

total TCPI = 0.930. Siemens also achieved the highest value for the CRI. The ranked results can be seen in Table 8.

The first position was occupied by Siemens, the second by Sony Corporation, and the third by Samsung. The results of the first three positions differ by hundredths of a percent. In contrast, the difference between the last and penultimate companies, i.e., between Nintendo and Panasonic, is significant, namely by 0.47. This means that the company is the only one in the sample that does not generate a shared value. However, there is still a lot of room for improvement in the case of Panasonic and Intel. Panasonic should improve the form and content of CSR reports (CRI reporting indicator). Poor reporting has the effect of lowering the overall corporate profile of a company. Nintendo should increase its CSR reporting activity (CRI indicator) and should create shared value (TCPI value < 0.5 - no shared value is created). Panasonic should increase CSR reporting clarity (by using GRI standards, which it does not use yet). It should set specific and ambitious targets and provide a picture of how it will use corporate resources to achieve these targets. Not all these items were disclosed in the company's CSR report, which affected the company's overall score.

The result of this analysis is rather surprising. In the case of a literal search for the phrases "creating shared value", "shared value" or "value creation", it is almost impossible to find these phrases in individual CSR reports.

4. Discussion

CSV and CSR are similar in many ways (Wójcik, 2016). It can be agreed that it is difficult to separate these concepts from each other. This research was based on novel benchmarking-scoring system that had the objective of assessing how can corporate CSR reporting be used for evaluation of the existence of CSV in company as proposed for environmental accounting by Tsalis (2020). We were able to emphasize the need of assessing both the quality of revealed data and the actual development of company performance in CSV area.

The recommendation for businesses whose overall score came out high is that they should not stop creating shared value and they should continually look for new opportunities

to create shared value. Companies that did not score very high, but at the same time met the threshold that determined that they were creating shared value, should increase their efforts, and set ambitious targets that they are committed to meeting. Furthermore, communication with the public, i.e., the form of CSR reports, can be improved. The quality of reports will be improved by adhering to GRI standards. We identified two companies that mostly do not line up with the definition of CSV defined by Salonen and Camilleri (2020) who state that CSV unites the company with society so that the company produces money and at the same time raises living standards in the neighborhood.

The benchmarking-scoring methodology could be more conclusive and more telling if more key indicators that create shared value could be captured. This could also be achieved by modifying the GRI standards, which focus on many key themes of CSR activities. If these themes were applied to the concept of shared value creation, the analysis would be more conclusive, and the results obtained could differ.

For greater clarity and systematic alignment, it is advisable for companies to use GRI standards. Some of the company's own reports are not very clear, contain too much inaccurate text, and have a rather negative impact on the reader (the case of Panasonic). Many companies also disclose to a very limited extent how corporate resources are used to finance CSR activities.

5. Conclusions

Indicators of shared value creation were identified, then investigated and searched through the analysis of CSR reports of 10 selected companies. Some of the sampled enterprises were found to have room for improvement and conversely, some were found to be creating shared value at a very high level.

The concept of corporate shared value is beneficial for the company, but also for its surrounding. If there is to be a change of mindset and the needs of both people and businesses are to be reduced, this must be done through systematic win-win action, not as haphazard manifestations in the case of the CSR concept. The creation of shared value will increase the market value of the company, and enhance its reputation, thereby increasing its competitiveness and at the same time creating better conditions for its environment, nature, or even its employees. This should be the direction in which the future of companies needs to be directed.

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The Impact of the Digital Economy on the Convergence of China's Regional Economic Growth

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Abstract: The development of digital economy can improve the efficiency of resource allocation and thus enhance the vitality of regional economic development. Based on the analysis of the development of digital economy in China from 2012 to 2018, this paper uses the conditional β convergence mechanism to examine the impact of digital economy on the economic growth rate of different regions in China and the impact path. The results show that: (1) China's digital economy is developing rapidly, with obvious development characteristics from coastal to inland, and there are certain differences in the development degree of digital economy, but this difference in the development of digital economy is decreasing. (2) There is a phenomenon of economic convergence in China's different provincial administrative regions. The improvement of the human capital level can promote regional economic convergence, while corporate R&D expenditure and foreign direct investment weaken the regional economic convergence effect. (3) The development of digital economy enhances the convergence effect of regional economy through the improvement of corporate R&D expenditure and human capital level, while industrial structure upgrading, foreign direct investment in combination with digital economy shows the inhibitory effect on economic convergence.

Keywords: digital economy; conditional β convergence; coordinated development of regional economy

JEL Classification: E61; E65

1. Introduction

The digital economy is an economic form which has a strong role in driving regional economic growth. According to the *White Paper on China's Digital Economy Development* released by the China Academy of Information and Communications Technology in July 2022, the value added of China's digital economy reached 45.5 trillion yuan in 2021 which was growing 16.2 percent year on year, accounting for 39.8 percent of GDP. The features of digital economy determine that developing digital economy is the necessary path for China to achieve high-quality economic growth. Digital economy is not only an endogenous driving force to optimize allocation of productive factors and increase returns to scale, but an important driving force that achieves inclusive growth and coordinated regional development (World Bank, 2016). At present, China's economy has shifted from a stage of high-speed growth to a stage of high-quality development, and regional coordination will

become an important driving force for high-quality development. In March 2021, the *Chinese government's Report on the Work of the Government* pointed out that digital industrialization and digitalization of industry should be promoted coordinately. There is a close connection between digital economy and regional coordinated development. To clarify the relationship between the two is of great practical significance for narrowing the economic gap between regions, reshaping the pattern of regional economic growth, and promoting the high-quality development of macro economy.

The research on the mechanisms of digital economy's effect on regional coordinated development needs to be improved. This paper analyzes the convergence of regional economy under the condition of digital economy, and explores the specific path of digital economy influencing the coordinated development of regional economy from four aspects: regional industrial structure, innovation level, openness and human capital. This paper further clarifies the effect mechanism of digital economy on regional economic growth, and provides empirical evidence for digital economy driving regional economic coordinated development.

This paper finds that China's digital economy is developing rapidly, and there are some differences in the development degree between the eastern, middle and western regions and within regions. However, in recent years, the development difference of digital economy shows a continuous downward trend both from the national level and the regional level. In addition, there is a significant economic convergence in different provincial administrative regions in China, and the development of digital economy can regulate the economic convergence through the channels of industrial structure, enterprise research and development, foreign investment, and human capital. In order to promote the coordinated development between different regions, it is significant to give full play to the positive regulating effect of digital economy on regional economic convergence and prevent its disorderly expansion in a few developed regions.

2. Literature Review

In the modern society with increasingly fierce competition of comprehensive national strength, the development of digital economy based on information technology, with the nature of high penetration, external economy and increasing marginal returns, and it has attracted widespread attention from different countries. At present, the relatively authoritative definition of digital economy comes from the G20 Digital Economy Development and Cooperation Initiative at the G20 Hangzhou Summit. It states that digital economy refers to a series of economic activities that use digital knowledge and information as key factors of production, modern information network as an important carrier, and effective use of information and communication technology as an important driving force to improve efficiency and optimize economic structure. Digitalization will affect all aspects of people's economic life, such as online payment, administrative office and electronic communication (Teau, 2014). In recent years, with the rapid development of domestic information infrastructure construction, digital economy has effectively supported the promotion of digital China strategy, and has become a new driving force for the high-quality

development of China's economy under the new normal (Liu, 2019). It can be seen that digital economy, with its wide scope and depth of influence, will have an important impact on the coordination of economic development among regions and the sustainability of economic development within a region.

At present, there are two opposite views on the role of digital economy in the coordinated development of regional economy Views. One view is that the development of digital economy related industries can promote regional economic growth (Jorgenson & Nomura, 2005), and the economic growth pole will have a diffusion effect on the surrounding regions under a series of linkage mechanisms, and then drive the coordinated development of surrounding regions (Perroux, 1950). With the popularization of the Internet, the digital economy has developed rapidly and narrowed the income gap between urban and rural regions (Gao & Zang, 2018). In addition, the digital economy is conducive to knowledge diffusion and technology spillover, thus narrowing the differences in economic development between different regions (Forman & Zeebroeck, 2018). Another view is that the application of digital technology has different effects on improving the productivity of different market players, which may lead to polarization (Amuso et al., 2020). Specifically, the popularization of digital technology and the unbalanced configuration of digital skills restrict the development of underdeveloped regions, aggravating the imbalance of regional economic development (Jin & Li, 2016).

Through a large number of studies, domestic and foreign scholars have found that industrial structure, technological progress, foreign trade, resource endowment and other factors cause regional development differences (Krugman, 1991; Deng & Gong, 2018). The industrial economic structure plays a fundamental role in the economic development of a country, and the rise of new infrastructure will affect the industrial structure of the national economy (Brynjolfsson & Hitt, 2000). The construction of digital infrastructure can help accelerate the digital transformation and upgrading of traditional industries. And improving the quality of economic development (Han et al., 2020). The deep integration of digital technology and the real economy has cultivated new growth points in many fields, and optimized the allocation of factors between regions. The innovative and efficient characteristics of digital are in line with the requirements of high-quality development, and the development of digital economy can improve the efficiency of technological innovation, the development of digital economy can improve the efficiency of technological innovation (Kleis et al., 2012). In addition, in the foreign investment of digital multinational enterprises, digital technology and infrastructure quality, play an increasingly important role in the direction of international investment flows, and foreign investment can more effectively promote economic development in countries with low levels of economic fluctuations (Mody & Murshid, 2011). Labor is also a key factor that cannot be ignored in the economic market. In the case of labor skill heterogeneity, the ability gap caused by the skill difference of digital equipment users may widen the economic development gap between underdeveloped regions with low-skill labor and developed regions with high-skill labor power (Hawash & Lang, 2011).

To sum up, accurately defining and measuring digital economy is the basis for studying related issues, and the contribution of digital economy to high-quality economic development has been recognized by most scholars. Therefore, it is of great significance for China's high-quality economic development to explore the path to achieve coordinated regional development. Based on this consideration, this paper will conduct an in-depth analysis of the development of digital economy in China, economic convergence in different regions, and the adjustment channels of digital economy to economic convergence, in order to provide policy suggestions for the high-quality development of digital economy.

3. Identification Method and Calculation Result

To analyze the time series and identify the spatial distribution characteristics of China's digital economy development from 2012 to 2018, This paper uses the digital economy development index in *China Digital Economy Index Report*, and draws the spatial distribution maps of China's digital economy development index in 2012, 2015 and 2018 (Figure 1.) by Geoda software. It can be seen from Figure 1 that the development of China's digital economy shows an obvious feature of gradient. Digital economy first emerged in the eastern region, and perfect infrastructure and open ideas laid a good foundation for the development of local digital economy, especially in the southeast coastal provinces. Under the background of rapid development of informatization, digital economy develops rapidly in inland regions with perfect information infrastructure due to its fast and direct characteristics, and forms a diffusion circle of digital economy with these provinces as the core. From the perspective of spatio-temporal evolution characteristics, China's digital economy is developing rapidly and the overall situation is good.

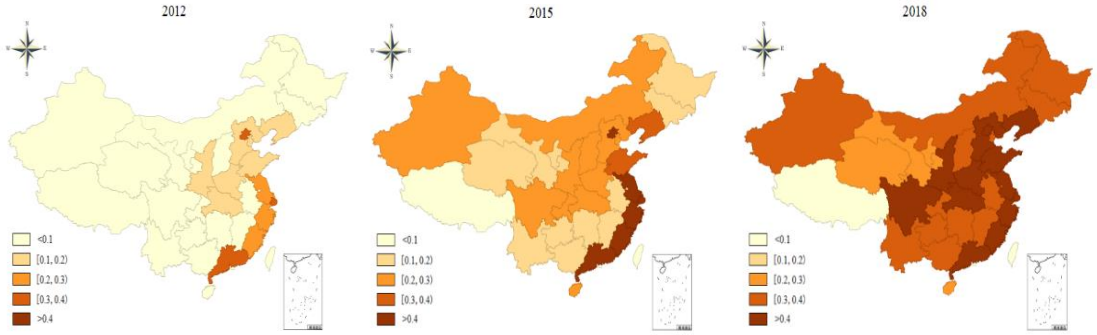

Figure 1. Spatio-temporal evolution of China's digital economy development

To deeply understand the development status of China's digital economy, this paper uses the digital economy development difference index (DI) to measure the different degree of China's digital economy development, which is expressed by the ratio of the standard deviation of the observation sample to the sample mean. The larger the value is, the smaller the gap of digital economy development between different regions is. Otherwise, it indicates that there is a large gap in the development of digital economy in different regions. The calculation of digital economy development difference index is shown in Formula (1):

$$DI = \frac{\sqrt{\frac{1}{n}\sum_{i}^{n}(x_i - \bar{x})^2}}{\bar{x}} \quad (1)$$

In Formula (1), *i* represents different provincial administrative regions, and *n* is the sample number of provincial administrative regions (*n* = 30). x_i represents the digital economy development index of different provincial administrative regions, and Xbar represents the average value of the digital economy development index of different provincial administrative regions.

This paper first measures the development difference of China's overall digital economy. It can be seen from Figure 2 that the development difference index of China's overall digital economy shows a continuous downward trend, from 0.834 in 2012 to 0.393 in 2018, with an average annual decline rate of 13.4%. In 2012, the digital economy development disparity index decreased by 39.3 percent, and then the rate of decline tended to be stable. By breaking the limitations of traditional geographical space, digital economy has greatly developed people's consumption potential, and also fully empowered the further development of digital economy, realizing the rapid development of China's digital economy.

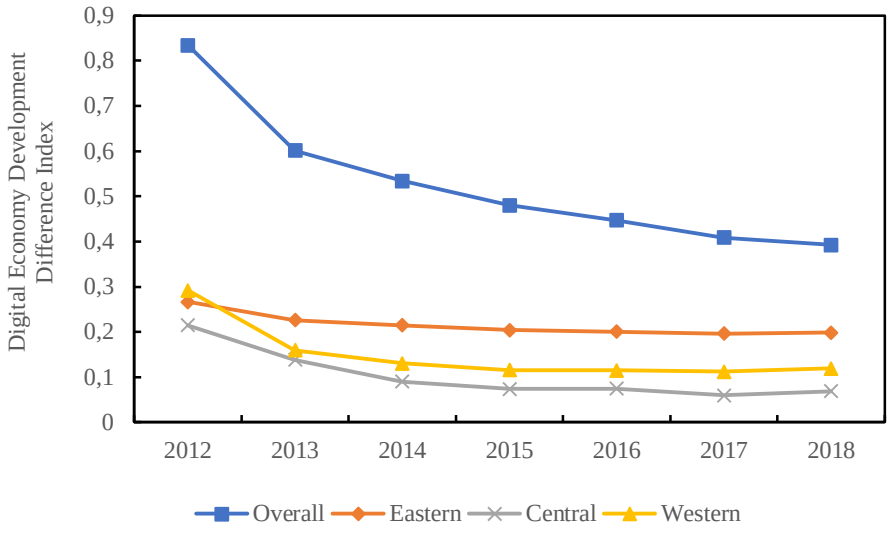

Figure 2. Dynamic trends of China's digital economy development in different regions

Due to the differences in location conditions, China's level of economic development shows a spatial gradient characteristic of gradual decline from southeast to northwest. The heterogeneity of economic environment may lead to the differentiated development of digital economy, and then affect the coordinated development between regions. Therefore, it is necessary to analyze the differences in the development of digital economy in the eastern, middle and western regions. It can be seen from Figure 2 that the development differences of digital economy in the eastern, middle and western regions basically maintain a downward trend, indicating that the development of digital economy in the region tends to be balanced. Among them, the digital economy development difference index in the eastern region decreased from 0.267 in 2012 to 0.198 in 2018, with an average annual decrease of 5.1%; In the central region, it decreased from 0.215 to 0.069, with an average annual decrease of 20.9%; In

the western region, it decreased from 0.292 to 0.119, with an average annual decrease of 16.1%. There are obvious differences in the development of digital economy in different regions. The mean values of the digital economy development difference index in the eastern, central and western regions are 0.215, 0.103 and 0.149 respectively. Although the overall level of digital economy development in the eastern region is relatively high, there may be a "siphon phenomenon" among different provinces, because the digital economy is self-expanding. Under the influence of people's psychological reactions and behavioral inertia, when the advantages or disadvantages of the digital economy reach a certain extent, such advantages or disadvantages will be magnified by themselves. The digital economy in the western region has not been fully developed, especially in the northwest region, Sichuan and Shaanxi provinces are the highlands of digital economy development in western China, and the overall development of digital economy varies greatly among different provinces. The central region fully enjoys the spillover effect of the digital economy in the eastern region. At the same time, the dense population in the central region magnifies the external economy and promotes the rapid development of the local digital economy.

In general, China's digital economy develops rapidly, and shows gradient feature in different regions. There is a big gap between the southeast regions and the northwest regarding the development level of digital economy. In addition, the difference of digital economy in China shows a downward trend, but the decline rate in the eastern region is the slowest. In the development of digital economy, it is necessary to prevent the disordered expansion of digital economy in a few developed regions. The disordered self-expansion of digital economy will be contrary to the original intention of benefiting people's livelihood and promoting regional coordinated development.

4. Results and Discussion

Based on the neoclassical growth theory and considering other factors that affect the coordinated growth of regional economy, this paper uses the conditional β convergence mechanism to examine the impact of digital economy on the economic growth of different regions in China. China's regional coordinated development strategy emphasizes the relative equality of economic development in different regions, rather than the "absolute average", so promoting different regions to achieve economic equilibrium under their own external conditions is the key to achieving regional coordinated development strategy.

Existing studies have shown that digital economy, industrial structure, scientific research and innovation, foreign investment and human capital will all have an impact on the coordinated development of regional economy. Considering the completeness of the data, this paper takes 30 provincial administrative regions in China from 2012 to 2018 as the research unit. Among all the variables, the digital economy development index is obtained from the *China Digital Economy Index Report*, and the data of other variables are mainly from the *China Statistical Yearbook*. The missing part was completed by the *Statistical Bulletin of National Economic and Social Development* of different provincial administrative regions. In order to empirically test the specific effects of the above factors on economic convergence in different regions, this paper constructs the following model for analysis:

$$ln(y_{it+1}/y_{it}) = \beta_0 + \beta_1 lny_{it} + \beta_2 X_{it} + \beta_3 (lny_{it} * X_{it}) + \varepsilon_{it} \quad (2)$$

In Formula (2), *i* represents the provincial administrative region and *t* represents the year; y_{it} represents per capita GDP (*pgdp*), which is the core explanatory variable and reflects the local economic development; (y_{it+1}/y_{it}) represents the ratio of the per capita GDP of a provincial administrative region in the current year to that last year, and is the explained variable, reflecting the local economic growth; X_{it} includes five control variables: digit economic development index (*digit*), the proportion of total output value of tertiary industry (*serv*), enterprise R&D expenditure (*rd*), actual utilized foreign direct investment (*fdi*), and the proportion of university students (*hc*). β is the parameter to be estimated, where β_1 is the conditional convergence coefficient, β_2 reflects the effect of control variables on regional economic growth, β_3 It reflects the direction and magnitude of the influence of control variables on economic convergence; Epsilon.it Is the random disturbance term with normal distribution.

Table 1. Estimation results of conditional β spatial convergence.

	(1)	(2)	(3)	(4)	(5)	(6)
lnpgdp	-0.069*** （0.024）	-0.085 （0.054）	-0.223*** （0.066）	-0.213*** （0.063）	0.008 （0.051）	-0.308** （0.147）
digit	-1.152* （0.626）					-0.852 （1.981）
serv		-1.403 （1.154）				-1.450 （1.996）
lnrd			-0.303*** （0.116）			-0.513 （0.322）
lnfdi				-0.303*** （0.105）		-0.149 （0.176）
hc					8.525 （26.744）	65.135* （35.385）
*lnpgdp*digit*	0.110** （0.056）					-0.138 （0.142）
*lnpgdp*serv*		0.129 （0.105）				0.134 （0.180）
*lnpgdp*lnrd*			0.029*** （0.011）			0.048* （0.030）
*lnpgdp*lnfdi*				0.029*** （0.010）		0.015 （0.017）
*lnpgdp*hc*					-0.918 （2.449）	-6.102* （3.237）
_cos	1.801*** （0.251）	1.985*** （0.581）	3.386*** （0.708）	3.288*** （0.663）	1.012*** （0.549）	4.316*** （1.592）
R^2	0.283	0.122	0.270	0.104	0.039	0.223
F-value	8.67***	3.51***	15.45***	14.13***	2.76***	20.98***
N	210	210	210	210	210	210

Note: ***P < 0.01, **P < 0.05, robust standard errors in parentheses.

Table 1 reflects the impact of control variables on economic convergence. The regression results of the interaction terms between regional economic development level and different factors on economic growth rate are reported in the five models (1), (2), (3), (4) and (5) respectively. The conditional convergence coefficient is significantly negative, indicating that

there is economic conditional convergence phenomenon in different provincial administrative regions of China. In addition, the impact of digital economy development, enterprise R&D expenditure and foreign direct investment on regional economic growth is significantly negative, and the impact of the proportion of the total output value of the tertiary industry is negative but not significant. The ratio of the number of students in colleges and universities has a significantly positive impact on regional economic growth. Therefore, the marginal utility of digital economy development, R&D expenditure and foreign direct investment on economic growth is decreasing. The human capital plays an obvious role in promoting economic growth. Under the circumstance of downward pressure on the economy, the investment in human capital should be moderately strengthened to enhance the driving force of economic development. In order to examine the impact of digital economy, industrial structure, enterprise research and development expenditure, foreign direct investment and human capital level on regional economic convergence, this paper introduces the cross-term between regional economic development level and control variables while conducting regression on each control variable. It can be seen from the Table that the development of digital economy, the R&D expenditure of enterprises and the actual use of foreign direct investment weaken the regional economic convergence effect, which is not conducive to the realization of regional economic equilibrium, while the level of human capital can promote regional economic convergence. In addition, the proportion of the total output value of the tertiary industry has no significant effect on the convergence of the economy.

According to the existing research, the development of digital economy will affect economic convergence by moderating industrial upgrading, innovation and R&D, foreign investment and human capital. How will digital economy affect regional economic convergence? In order to explore the channels, direction and magnitude of the effect of digital economy on economic convergence, this paper extends Formula (2) as follows:

$$ln(y_{it+1}/y_{it}) = \beta_0 + \beta_1 lny_{it} + \beta_2 digit_{it} + \beta_3 X_{it} + \beta_4 (lny_{it} * X_{it}) + \beta_5 (lny_{it} * X_{it} * digit_{it}) + \varepsilon_{it} \quad (3)$$

In Formula (3), (y_{it+1}/y_{it}) is the dependent variable; y_{it}, $digit_{it}$ are the core explanatory variable, $digit_{it}$ represents the development level of digital economy; X_{it} are control variables, the variable Settings remain the same as above. In order to investigate the moderating effect of digital economic development on economic growth under the existing industrial structure, enterprise R&D expenditure, foreign investment and human capital, Formula (3) further adds the interaction item of digital economic development index based on the interaction item introduced in Formula (2). The interaction term of economic development level (*pgdp*), control variables (*serv*, *rd*, *fdi*, *hc*) and digital economic development index (*digit*) is formed. β_1 is still the conditional convergence coefficient, β_2 reflects the specific role of digital economy development on regional economic growth. β_3, β_4 are the specific effects of control variables on regional economic growth and the effects of control variables on economic convergence The direction and magnitude of the response; β_5 reflects the influence of control variables on economic convergence under the moderating effect of digital economy direction and magnitude.

Table 2. Moderating effect of digital economic development

	(1)	(2)	(3)	(4)	(5)
lnpgdp	0.158 （0.121）	-0.216* （0.131）	-0.223** （0.096）	-0.010 （0.074）	-0.280* （0.209）
digit	-0.552** （0.246）	-0.019 （0.235）	0.053 （0.203）	-0.029 （0.179）	-0.480* （0.630）
serv	4.463* （2.647）				5.836* （3.465）
lnrd		-0.293 （0.238）			-1.103** （0.463）
lnfdi			-0.297* （0.162）		0.043 （0.277）
hc				12.386 （36.468）	7.410 （42.499）
*lnpgdp*serv*	-0.444* （0.252）				-0.598* （0.332）
*lnpgdp*serv*digit*	0.113*** （0.043）				0.196*** （0.064）
*lnpgdp*lnrd*		0.029 （0.023）			0.105** （0.045）
*lnpgdp*lnrd*digit*		-0.001 （0.003）			-0.009 （0.008）
*lnpgdp*lnfdi*			0.029* （0.016）		0.004 （0.027）
*lnrgdp*lnfdi*digit*			0.001 （0.003）		0.001 （0.006）
*lnpgdp*hc*				-1.305 （3.464）	-0.425 （4.037）
*lnrgdp*hc*digit*				-1.381* （0.762）	-1.531 （1.036）
_cos	-0.497 （1.263）	3.314** （1.357）	3.382*** （0.981）	1.199 （0.765）	4.095* （2.204）
R^2	0.085	0.263	0.142	0.152	0.202
F-value	13.90***	14.91***	14.68***	4.51***	33.56***
N	210	210	210	210	210

Note: ***P < 0.01, **P < 0.05, robust standard errors in parentheses.

Table 2 shows the influence of control variables on economic convergence under the adjustment of digital economy. The core explanatory variables' regression coefficient is significantly negative, which proves that there is a trend of conditional convergence in different regional economies, and the marginal utility of digital economy for regional economic growth is decreasing. Among all the control variables, except the total output value of the tertiary industry Except for the proportion, the other regression results are basically consistent with those in Table 1, which further demonstrates the validity of the regression results of Formula (1). In addition, in model (1), the regression coefficient of the cross-term (*lnpgdp*serv*) between the economic development level and the proportion of the total output value of the tertiary industry is significantly negative, and the regression coefficient of the cross term (*lnpgdp*serv*digit*) is significantly positive, indicating that the development of digital economy will offset the promotion effect of industrial upgrading on economic convergence; In models (2) and (3), the regression coefficients of the interaction terms

(*lnpgdp*lnrd* and *lnpgdp*lnfdi*) between the level of economic development and enterprise R&D expenditure and actual utilization of foreign direct investment are positive, and the regression coefficients of the interaction terms (*lnpgdp*lnrd*digit*) are negative. The regression coefficient of the interaction term (*lnpgdp*lnfdi*digit*) is positive. This shows that the development of digital economy is conducive to the promotion of regional enterprise scientific research investment for economic convergence, but there is no way to promote regional economic convergence through foreign investment channels. In model (4), the regression coefficient of the interaction term (*lnpgdp*hc*) between economic development level and the proportion of high school enrollment is negative, and the regression coefficient of the interaction term (*lnpgdp*hc*digit*) is also negative and the value decreases, indicating that the development of digital economy, The development of digital economy can enhance the role of regional human capital improvement in promoting economic equilibrium.

There are convergence phenomena of economic conditions in different provincial administrative regions in China. Some scholars have discussed the relationship between digital economy and economic convergence from the regional and urban levels respectively, and found that the development of digital economy can improve the speed of economic convergence between regions (Li & Du, 2022), and its effect is heterogeneous in different regions (Shao & Chen, 2022). Consistent with the conclusion of most relevant studies, this paper argues that digital economy will help narrow the economic development gap between different regions. In addition, some scholars believe that technological effect is the key mechanism for digital economy to affect regional economic convergence, that is, digital economy development has significant spatial spillover effect characteristics, and indirectly affects the difference of regional economic development level by narrowing the regional innovation gap (Jin & Yu, 2021). This paper focuses on the direct effect of digital economy development to economic development disparities. Specifically, under the conditions of digital economy, industrial resources and foreign investment tend to be distributed to a few developed regions, resulting in the loss of resources in most underdeveloped regions, thus hindering the process of economic convergence in these regions, resulting in the differentiation of economic development between different regions, which is not conducive to the coordinated development of regional economy. In addition, digital economy can promote the spillover of scientific research achievements and human capital of regional enterprises, thus driving the economy to a balanced state, developing the potential of regional economic growth, and reducing the difference of economic development levels in different regions.

5. Conclusions

With the deepening of China's economic reforms, the goal of high-quality economic growth encounter numerous obstacles. Therefore, Chinese government needs to transform the growth model to support the sustainable development of the Chinese economy. At present, the digital economy has shown strong vitality, it can promote the formation of economies of scale and maximize output under the given resource input. It has become a new driving force for China's economic growth.

This paper uses the conditional β convergence analysis method to test the transmission mechanism of digital economy affecting regional economic growth speed. The main conclusions of this paper are as follows: there are differences in the digital economy development between the eastern, central and western regions, but differences show a trend of continuous decline, economic convergence phenomenon occurs in different provincial administrative regions in China. In addition, the development of digital economy can promote regional economic convergence by exerting the spillover effects of enterprise R&D and human capital. However, the digital economy may cause excessive concentration of resources, which leads to faster economic growth in regions with higher levels of industrial structure and greater foreign investment intensity. It is not conducive to narrowing the regional development gap.

This paper has enlightening policy implications for further developing digital economy and promoting the formation of coordinated development patterns in different regions. First of all, it is necessary to avoid the emergence of digital divide. The gap in the development of digital economy between regions in China is not only caused by the level of infrastructure construction, but the difference in the ability to use digital equipment. It is equally important to improve people's ability to use digital equipment. Secondly, improving the sharing mechanism of enterprises' R&D achievements is as important as promoting the matching of supply and demand information of foreign investment, which can effectively solve the practical problems of backward science and technology and lack of development funds in underdeveloped regions. Finally, it is necessary to stimulate the potential of digital economy and narrow the regional development gap by formulating targeted digital economy development strategies according to the actual situation of different regions.

Conflict of interest: none

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Opportunistic Behavior and Ambidextrous Alliance: How to Use Different Governance Mechanisms to Success?

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Abstract: How to design the governance mechanism to avoid the negative effects of opportunistic behavior in ambidextrous alliance? Based on data collection from 370 enterprises as samples, this paper examines the relationship between opportunistic behavior and two types of ambidextrous alliance, and further studies the moderating effects of control governance and relational governance distinctively. The results show that opportunistic behavior negatively related to both exploratory alliance and exploitative alliance; the inhibitory effect of opportunistic behavior on exploratory alliance will be larger by using contract governance while be decreased with relational governance. On the contrary, the inhibitory effect of opportunistic behavior on exploitative alliance will be smaller by using contract governance, and relational governance can increase it. This study further deepens the understanding that alliance governance research.

Keywords: ambidextrous alliance; opportunistic behavior; governance mechanism; contract governance; relational governance

JEL Classification: M10; M15; M19

1. Introduction

With the increasingly fierce competition and the rapid innovating progress of science and technology, enterprises are generally faced with the problem of resource capacity deployment, dealing the dilemmas between efficiency and flexibility, convention and breakthrough (Lavie et al., 2012). No matter large enterprises or small enterprises, it is difficult to solve the contradictions among different internal activities by themselves. Therefore, more and more enterprises establish ambidextrous alliance to get rid of the constraint of internal resources and realize capability reconstruction. Based on complementary resources of partners, ambidextrous alliance can achieve such goals as sharing R&D investment, reducing R&D risks, shortening R&D cycle, gaining scale advantages, and rapidly entering new technologies or markets (Rothaermel & Deeds, 2006). However, with the increasing complexity of ambidextrous activities, a large number of ambidextrous alliances fail to achieve expected goals (Dyer & Singh, 1998). An important reason for this phenomenon is the opportunistic behavior in ambidextrous alliances, which cause disruptions and conflicts, and are viewed as a barrier to the success of inter-organizational transactions (Williamson, 1984). How to prevent and reduce opportunistic

behavior in ambidextrous alliance has become a problem that both theoretical research and enterprise practice must solve.

As an important way to manage alliance, contract and relational governance mechanism are the main instruments for dealing with opportunistic behavior. However, prior researches show double-sword effects of both contract and relational governance on opportunistic behavior, and consistent findings are far from being reached (Liu et al., 2009). Specifically, contract governance can set clear behavioral boundaries and detailed contracts to protect specific alliance investment so as to avoid opportunistic behavior, while will also erode positive attitudes and further encourage opportunistic behaviors; relational governance brings greater autonomy and creates more conditions for opportunistic behaviors, while is benefit for trust and cooperating culture for alliance. Given these inconsistent conclusions, how to effectively govern opportunism using contract or relational governance remains unclear. Further, the ambidextrous alliance can be divided into exploratory alliance and exploitative alliance, which can bring different innovative values. Specifically, exploratory alliance is the strategic cooperation between enterprises and upstream partners in new product development, new technology exploration, testing new methods and so on; exploitative alliance refers to the cooperation established between enterprises and downstream partners on sales network, franchise, brand franchise, etc. (Okamuro, 2007). Then, will the governance mechanisms be different for different types of ambidextrous alliances? If so, what kind of governance mechanism can be designed to work best? Unfortunately, the research for answering the governance problem of ambidextrous allianceon is very limited.

In order to make up for this lack of research, this paper will analyze the influence of opportunistic behavior on ambidextrous alliance, and further explore the moderating effects of two alliance governance mechanisms, contract governance and relational governance. The research in this paper is helpful to deeply understand the influence of governance mechanism on opportunistic behavior in ambidextrous alliance, and can also guide enterprises to design appropriate governance mechanisms to reduce opportunistic behavior in cooperative R&D and promote the success of the alliance.

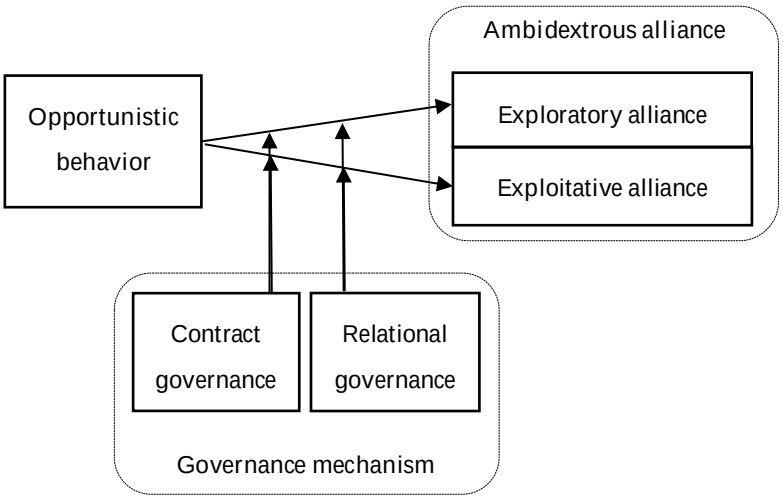

Figure 1. The proposed theoretical model

1.1. Opportunistic Behavior and Ambidextrous Alliance

Opportunistic behaviors refer to that in the case of information asymmetry, enterprise does not disclose all information truthfully and engages in other behaviors that benefit others at the expense of others, such as behaviors that making promises but failing to fulfill them, exaggerating needs to achieve expectations, changing facts to achieve expectations, etc. (Carson et al., 2006). Opportunistic behaviors adversely affect ambidextrous alliance in three ways. First, opportunistic behaviors reduce knowledge sharing between partners which resulting in the deficiency of both exploratory and exploitative alliance. If opportunism occurs, enterprises will terminate knowledge sharing and exchange in order to protect their core knowledge, thus inevitably affecting alliance performance. Second, opportunistic behaviors extremely reduce the trust between partners, further reduce the possibility and intensity of further cooperation. Third, it may shift enterprise' attention to preventing opportunistic behaviors, while ignoring the original purpose of alliance cooperation, which greatly reduces the efficiency of alliance, either for exploratory alliance or exploitative alliance.

- Hypothesis 1a: Opportunistic behavior negatively influence exploratory alliance.
- Hypothesis 1b: Opportunistic behavior negatively influence exploitative alliance.

1.2. The Moderating Effect of Contract Governance on Opportunistic Behavior and Ambidextrous Alliance

Contract governance means to explain and regulate the expected behavior in the process of cooperative research and development by signing contracts, and give partners the right to punish the violation of the rules, so as to prevent and reduce the intentional behavior of the parties to harm the interests of the other party and the behavior of making promises and not fulfilling them. At the same time, by signing contracts to regulate the behavior of the parties in the process of collaborative research and development, and using these standards to evaluate the behavior of the parties, the parties can avoid exaggerating the needs or changing the facts to achieve their expectations. In conclusion, contract governance can effectively reduce opportunistic behavior in collaborative research and development.

For exploratory alliance, enterprises try to acquire external knowledge of new technologies and processes, which is usually scattered and disordered with large knowledge width. It is difficult to make clear the acquisition, decomposition, integration and reorganization of such knowledge through clear behaviors or processes. In the process of cooperation, enterprises often face problems such as knowledge structure gap and lack of experience, so it is difficult to determine appropriate contracts and norms to reduce opportunistic behavior in this type of alliance, and the complexity and uncertainty of exploratory alliance aggravate this problem. Therefore, it is difficult for contract governance to alleviate the negative relationship between opportunistic behavior and exploratory alliance, but will aggravate its side effects.

On the contrary, the members of the exploitative alliance have similar resource reserves and knowledge structure, and the knowledge span is small. It is not only easier to decode

and absorb the invisible knowledge or situational knowledge such as market or customer acquired in the exploitative alliance, but also easy to form a stable and efficient convention and routine process. Therefore, it is easier to determine appropriate contracts and norms to reduce opportunistic behaviors in this type of alliance, so that contract governance can be used more effectively to prevent opportunistic behaviors, alleviate the negative relationship between opportunistic behaviors and exploitative alliance, and reduce its side effects.

- Hypothesis 2a: Contract governance positively moderating the relationship between opportunistic behavior and exploratory alliance, which means contract governance increase the negative effect of opportunistic behavior on exploratory alliance.
- Hypothesis 2b: Contract governance negatively moderating the relationship between opportunistic behavior and exploitative alliance, which means contract governance reduce the negative effect of opportunistic behavior on exploitative alliance.

1.3. The Moderating Effect of Relational Governance on Opportunistic Behavior and Ambidextrous Alliance

With a high level of relational governance, enterprise will consider the interests of partners and take reciprocal actions to protect the interests of alliance, rather than intentionally hurting the interests of the other party or making promises but not fulfilling them. At the same time, it emphasizes trusting partners, communicate honestly, and don't exaggerate needs or change facts to achieve desired goals.

For exploratory alliance, relational governance can alleviate the negative impact of opportunistic behavior on exploratory alliance. On the one hand, exploratory alliances often involve new knowledge and heterogeneous knowledge, and at the same time need new conventions and new practices to integrate new knowledge into organizational content. By emphasizing the maintenance of trust relationship, cooperative atmosphere and reciprocal actions among partners, relational governance enables enterprises to act consciously when a large number of unpredictable and implicit processes are involved, and can limit opportunistic behaviors from both emotional and value identification aspects, thus reducing the adverse impact on exploratory alliances. On the other hand, relational governance is more values-oriented and relatively free of complicated institutional and process constraints, so that enterprises can concentrate their limited energy on alliance objectives rather than preventing opportunistic behaviors, thus reducing the negative impact of opportunistic behaviors on alliance performance.

On the contrary, the knowledge span of exploitative alliance is small, and the difficulty of integrating different skills or knowledge between enterprises is low, which is easy to form organizational inertia in the process of iteration and upgrading of organizational conventions. If dependent on relational governance, it is easy for enterprises to be confined to fixed organizational conventions and routine processes, and it is difficult to detect or even encourage opportunistic behaviors. Therefore, relational governance is not conducive to mitigating the negative effects of opportunistic behaviors on exploitative alliances.

- Hypothesis 3a: Relational governance negatively moderating the relationship between opportunistic behavior and exploratory alliance, which means contract governance reduce the negative effect of opportunistic behavior on exploratory alliance.
- Hypothesis 3b: Relational governance positively moderating the relationship between opportunistic behavior and exploitative alliance, which means contract governance increase the negative effect of opportunistic behavior on exploitative alliance.

2. Methodology

2.1. Sample and Data Collection

We collected data through a survey in China. The samples were randomly selected out of firm lists offered by MBA centers and local High-tech Industrial Development Zones. We filed-interviewed or emailed the questionnaire with an explanation of the objectives and requirements of the survey. 494 firms finally accomplished the questionnaires, and finally we received 370 valid questionnaires with an effective response rate of 74.9%. All the respondents were senior executives such as CEO, COO or CFO which had at least three years' management experiences in target firms so as that they well understood status quo of the firms.

2.2. Measures and Analysis

All the measures (see Table 1), except those special stated, were measured on a 5-point Likert scale, ranging from "1" representing "strongly disagreement" to "5" represents "strongly agreement". We adopted the measures of exploratory (Cronbach's alpha = 0.899) and exploitative alliance (Cronbach's alpha = 0.859) suggested by Rothaermel and Deeds (2006), Yang et al. (2014), Atuahene-Gima and Murray (2007). Opportunistic behavior (Cronbach's alpha = 0.872) was measured with a 4-item scale developed by Rokkan (2003), Wuyts and Geyskens (2005). Contract governance (Cronbach's alpha=0.814) and relational governance measured (Cronbach's alpha=0.855) were all developed by Jap and Ganesan (2000) and Poppo et al. (2002) with a 4-item scale respectively. To account for the alternative explanations of the factors outside the model, four variables were incorporated and controlled: (1) Firm size which was measured by the number of a firm's full-time employees with an ordinal scale (1: fewer than 50; 2: 51-200; 3: 201-500; 4: 501-1000; 5: more than 1000) (Graves & Langowitz, 1993; Zahra et al., 2000). (2) Firm age was measured by the years since the firm was established (1): fewer than 3 years; 2: 3-5 years; 3: 6-10 years; 4: 11-30 years; 5: more than 30 years). (3) Technology uncertainty was comprised with five items according to the work of Jaworski and Kohli (1993) (Cronbach's alpha = 0.848). (4) Alliance stability was comprised with three items according to the work of Sohi et al. (2008) (Cronbach's alpha = 0.783). To analyze the proposed model, we applied SPSS 20.0.

3. Results

3.1. Descriptive Statistics Results

We conducted descriptive statistics and correlation analysis. The correlation matrix, means and standard deviations for the variables are also been reported in Table 1.

Table 1. Descriptive statistics and correlations

Variables	Mean	S.D.	1	2	3	4	5	6	7	8
1 Firm size	3.68	1.12	1							
2 Firm age	3.49	1.647	.448**	1						
3 Technology uncertainty	0.0023	0.85607	.124**	.145**	1					
4 Alliance stability	0.0038	0.85566	0.024	0.058	.109*	1				
5 Exploratory alliance	0.0013	0.85434	-0.014	-0.018	.273**	.265**	1			
6 Exploitative alliance	0.0027	0.79374	-0.042	-0.054	.229**	.273**	.535**	1		
7 Contract governance	0.0019	0.81633	0.008	0.053	.216**	0.077	.192**	.218**	1	
8 Relational governance	0.0016	0.82912	-0.026	0.046	.247**	.452**	.309**	.393**	.255**	1
9 Opportunistic behavior	-0.003	0.81834	-0.011	-0.039	.094*	-.116*	-.107*	0.014	.237**	-.104*

Note: No. of samples is 370. * $p < 0.05$, **$p < 0.01$, ***$p < 0.001$ (two tailed).

3.2. Reliability and Validity

First, we conducted an exploratory factor analysis on the scale items by the principal component method rotated with Varimax, and all the factor loadings are above 0.7 indicating high convergent validity (Fornell & Larcker, 1981). And average variance extracted (AVE) for all constructs were also computed and greater than 0.50, which still got good verification of validity. Second, the reliability analyses were conducted. We computed the Cronbach's alpha values and reported in the Chapter of Methodology. And all constructs have a composite reliability (CR) value greater than 0.875, above the cut-off of 0.7, implying that the variance captured by the factor is significantly more than the variance indicated by the error components (Bagozzi & Yi, 1988).

3.3. Hypotheses Testing Results

Table 2 shows the results of the regression analysis. Model 1 and Model 4 are the regression results of control variables on exploratory alliance and exploitative alliance respectively. Model 2 and Model 5 added independent variable, and the results showed that opportunistic behavior negatively influenced on exploratory alliance ($b = -0.163$, $p < 0.001$; Model 2) and exploitative alliance ($b = -0.071$, $p < 0.05$; Model 5). Thus, Hypothesis 1 was supported. To test the moderating effect of control variables, all the relevant interactions were entered. Model 3 showed that the interactive effect of contract governance and opportunistic behavior on exploratory alliance was significantly positive ($b = 0.106$, $p < 0.05$), while the interaction of relational governance and opportunistic behavior was significantly negative ($b = -0.044$, $p < 0.05$). Thus, Hypothesis 2 is supported. Meanwhile, Model 6 showed that the interactive effect of contract governance and opportunistic behavior on exploitative alliance was significantly negative ($b = -0.048$, $p < 0.1$), while the interaction of relational governance and opportunistic behavior was significantly positive ($b = 0.063$, $p < 0.05$). Thus, Hypothesis 3 is supported. We also used slope tests to further demonstrate the moderating effects of contract and relational governance on the relationship between opportunistic behavior and exploratory/exploitative alliance.

Table 2. Results of regression analysis

Variables	Exploratory alliance			Exploitative alliance		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Firm size	0.118***	0.113***	0.114***	0.114***	0.114***	0.107***
Firm age	0.092***	0.105***	0.100***	0.114***	0.118***	0.118***
Technology uncertainty	0.334***	0.339***	0.351***	0.213***	0.231***	0.231***
Alliance stability	0.159***	0.165***	0.157***	0.144***	0.134***	0.130***
Contract governance (CG)	0.112*	0.152***	0.146**	0.149***	0.176***	0.179***
Relational governance (RG)	0.126*	0.080	0.072	0.257***	0.237***	0.233***
Opportunistic behavior (OB)		-0.163***	-0.139**		-0.071*	-0.057*
CG×OB			0.106*			-0.048†
RG×OB			-0.044*			0.063*
R^2	0.255	0.281	0.288	0.287	0.301	0.305
ΔR^2	0.219	0.241	0.242	0.252	0.264	0.264
F Stats	6.978***	7.026***	6.294***	8.183***	8.113***	7.473***

Note: No. of samples is 370. † p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001 (two tailed)

4. Discussion

Using survey method, this paper reveals the influencing mechanism of contract governance and relational governance in solving opportunistic behavior problems, and explores the matching relationship between governance mechanism and ambidextrous alliance. It is found that contract governance and relational governance have opposite effects on different types of ambidextrous alliances. In exploratory alliance, it is suitable to adopt relational governance rather than contract governance. On the contrary, in the exploitative alliance, contract governance is suitable but relational governance is not suitable.

4.1. Theoretical Implications

From the perspective of organizational ambidexterity, this paper discusses the governance of ambidextrous alliance. This paper proposes new perspectives and conclusions for existing studies on how to use governance mechanisms to deal with inconsistent research conclusions on opportunistic behavior. Specifically, from the perspective of contract governance, some studies believe that explicit contract can set clear behavioral boundaries and detailed contracts can be used as the key to protect specific alliance investment, while others point out that regularization and control brought by contract governance will erode positive attitudes and encourage opportunistic behaviors (Liu et al., 2009; Lin & Ho, 2021). In response to these inconsistencies, this study points out that the key lies in the failure to distinguish the types of alliances, and shows that the effect of contract governance in the exploitative alliance is obvious, which supports the former view; well, the effect of contract governance in exploratory alliance is not good, which supports the latter view. There are also disunity and contradictions in the studies on relationship governance. Some studies believe that relational governance brings greater autonomy and hidden space for behaviors, creating conditions for the occurrence of opportunistic behaviors, while others emphasize its beneficial role in increasing trust and other aspects. Similarly, this paper gives an explanation for different types of alliances, that is, relationship governance in exploitative alliances is not

effective, on the contrary, exploratory alliances can significantly inhibit opportunistic behavior. Therefore, the conclusions of this paper reconcile the contradictions of previous studies, and show the effects and influence boundaries of different governance mechanisms from the contingency perspectives.

Furthermore, this paper points out that a mixed and complex governance mechanism is needed to effectively avoid opportunistic behaviors. In the ambidextrous alliance, enterprises cooperate with different business contents (such as R&D activities or marketing), different departments and different levels. Therefore, the forms and levels of opportunistic behaviors are diversified (Seepana et al., 2020). Considering the contrasting effects brought by different types of governance methods, it is necessary to organically combine various governance methods such as contracts, norms, interpersonal relations and trust. It needs to be combined with the selection of appropriate governance ways to produce targeted effects, and more importantly, a complex multi-dimensional governance mechanism is needed. Thus, this study further deepens the understanding that governance mechanisms affect the effectiveness of opportunistic behavior in ambidextrous alliances.

4.2. Practical Implications

Governance mechanism is an important means to reduce opportunistic behavior in alliance. In order to achieve the goal of cooperative research and development, managers need to adopt targeted governance methods according to the characteristics of the alliance and pay attention to the matching of methods and situations. For example, in exploratory R&D cooperation, it is difficult to observe the implicit thinking and hidden behavior of innovation partners, so it is more appropriate to carry out trust construction, reciprocal behavior, and relationship governance. In the incremental innovation or exploitative cooperation, it is better to clarify the rules and behavior boundaries so as to adopt contractual governance. Therefore, only by fully considering the matching of governance mode and governance situation can opportunistic behaviors be effectively avoided. At the same time, managers need to pay attention to the comprehensive application of a variety of methods, rather than adopt a single, universal method, but need to pay attention to the flexible transformation between methods.

4.3. Limitations and Directions for Future Research

This study also has some limitations and points out the direction for future research. First, cross-sectional data is used to verify the hypothesis proposed in this paper, and the evolutionary relationship among different types of ambidextrous alliance, governance mechanisms and opportunistic behavior cannot be found. Future studies can be further analyzed with longitudinal data. Second, the data in this paper is provided by only one party of alliance. Although the validity of this method is generally recognized and widely used in prior research, if data can be obtained from each party it will increase the credibility of the research and deepen the theoretical understanding. Finally, this paper fails to investigate the multifaceted nature of opportunism and does not discuss the mechanism of different types of opportunism. Future studies can distinguish the strong and weak forms of opportunistic

behaviors based on whether they violate written contract norms or implicit relationship norms, and adopt more detailed measurement indicators.

5. Conclusions

This paper empirically explores the effects of opportunistic behavior on two types of ambidextrous alliance, and further studies how control governance and relational governance distinctively influence these effects.

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Conflict of interest: none

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Research on the Influencing Factors of Rural Labor Transfer in China

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Abstract: Most of the existing literature studies the phenomenon of rural labor transfer in a specific province, city, or region in China, and rarely explores the overall rural labor transfer of China's overall rural labor force. In this paper, aiming at China's influencing factors of rural labor transfer and using several variables such as urban and rural consumption expenditure etc., the VAR model is constructed. Variance decomposition and the impulse response function are used to analyze and test its influence on rural labor force transfer rate. The results illustrate that the ratio of urban and rural consumption expenditure has extremely negative effect on the transfer rate of rural labor force after being impacted by external conditions. The urban unemployment rate has a very positive influence on the rural labor transfer rate after being impacted by external conditions. An impact of the income difference between urban and rural will bring positive effects to the rural labor transfer rate. A certain impact of the proportion of non-agricultural GDP to GDP will also bring significant positive effects to the rural labor transfer rate. Meanwhile, urban and rural consumption expenditure proportion has the most significant impact on the transfer rate of rural labor, while the proportion of non-agricultural GDP to GDP has the least impact on the transfer rate of rural labor.

Keywords: rural development; labor transfer; VAR model

JEL Classification: C10; E24; Q01

1. Introduction

After the New China established, China was poor and began to develop heavy industry, but it also neglected the development of light industry and agriculture, so there was a difficult period in the 20th century, people were unable to maintain food and clothing, and the problem of food and clothing became an urgent problem to be solved in New China. After the Reform and Opening-up, the household joint production contract responsibility system was vigorously implemented, and the problem of food rations for the people was solved, and then the central government vigorously developed the economy with economic construction as the center, and promoted China's urbanization process. The vigorous implementation of the household joint production contract responsibility system has greatly liberated the people's productive forces, and also made some peasants no longer bound to the land and began to move to areas outside the countryside. The process of urbanization is accelerating, increasing employment opportunities, expanding employment space, and gradually attracting rural labor to urban areas. On the one hand, the transfer of rural labor provides a large number of low-cost labor for urban construction, but it also induces a series of issues in

urbanization, simultaneously, the interests of migrant workers themselves are difficult to guarantee. In addition, rural areas have also encountered problems of unsustainable development due to rural labor transfer, and differences in income between urban and rural areas has been widening. At present, in rural development, many problems that have emerged are also related to rural labor transfer, such as industrial hollowing, the contradiction between village-to-village communication and no one in the village, etc., so studying the influencing factors of China's rural labor transfer can provide empirical evidence to solve the problems arising from the rural labor transfer in China.

As a large agricultural country, China's peasant issue has always been a social concern, and the socio-economic phenomenon of the transfer of rural labor in the process of urbanization has been favored by many scholars. Some scholars have explored the phenomenon of rural labor transfer in a specific province, city or region in China. Zhang and Wu studied the main factors of the transfer of rural surplus labor in Yibin, Sichuan Province, and analyzed these influencing factors by using Ling Regression (Zhang & Wu, 2010). Taking Gansu Province as a data sample, Su believes that the scale of regional economy, the absolute differences in income between urban and rural areas, the desired income level in urban, and the level of education are important factors for rural labor transfer to non-agricultural industries (Su, 2016). Based on the data of the 2007-2019 Weichuan County Statistical Yearbook, Dang and Liu studied the influencing factors of labor transfer in rural poor areas, and believed that the proportion of operating income would inhibit labor transfer (Dang & Liu, 2021). At the same time, some scholars have expanded their horizons to the country to study the labor transfer in China's rural area. Cheng and Shi believe that agricultural economic growth and rural reform have created conditions for the transfer of rural labor in China, and agricultural economy should be further developed (Cheng & Shi, 2007). You and Wu found that the transfer of farmland does not directly lead to the transfer of rural labor, and that unemployment or staying in farmland is the possible labor trend of farmers after transferring farmland (You & Wu, 2010). Qi quantitatively analyzed the contribution of non-agricultural transfer of rural labor to China's economic growth (Qi, 2014).

Vector autoregressive model (VAR) has not been used to analyze the influencing factors of the transfer of rural labor in China, and studying the influencing factors of the transfer of rural labor has reference significance for solving corresponding problems, so this paper constructs vector autoregressive model (VAR) to analyze the influencing factors of rural labor transfer in China.

2. Theoretical Model Construction

This paper constructs a theoretical model about the transfer of rural labor to urban through the cost-utility analysis of non-farm employment.

Hypothesis 1: There are two farmers, farmer 1 and farmer 2, and the utility of both is expressed as U1 and U2, respectively.

Hypothesis 2: There are two kinds of income, agricultural and non-agricultural income, simultaneously, agricultural income in rural and non-agricultural income in cities.

Assumption 3: Farmer 1 can have two incomes, Ya1 and Yi1, and Farmer 2 can have both Ya2 and Yi2 incomes, both of which bring utility, expressed as U1 (Ya1, Yi1) and U2 (Ya2, Yi2), respectively.

Assumption 4: The cost input rate for obtaining agricultural income is λa, the cost input rate for obtaining non-farm income is λi, the cost paid by farmer 1 for obtaining agricultural income and non-farm income is $\lambda a1Ya1+\lambda i1Yi1=C1$, and the cost paid by farmer 2 for obtaining agricultural income and non-farm income is $\lambda a2Ya2+\lambda i2Yi2 = C2$.

When the sum of the utilities of Farmer 1 and Farmer 2 is maximum, the distribution of the two incomes is optimal, so that it is obtained:

$$max(U1+U2) = max[U1(Ya1，Yi1) + U2(Ya2，Yi2)]$$

$$\lambda a1Ya1+\lambda i1Yi1 = C1$$

$$\lambda a2Ya2+\lambda i2Yi2 = C2$$

To build the Lagrange function:

$$L=U1(Ya1,Yi1)+U2(Ya2,Yi2)-W(\lambda a1Ya1+\lambda i1Yi1-C1)-M(\lambda a2Ya2+\lambda i2Yi2-C2)$$

Differentiating Ya1, Ya2, Yi1, and Yi2 respectively yields:

$$\partial L/\partial Ya1 = \partial U1/\partial ya1-W\lambda a1 = 0 \quad (1)$$

$$\partial L/\partial Ya2 = \partial U2/\partial ya2-M\lambda a2 = 0 \quad (2)$$

$$\partial L/\partial Yi1 = \partial U1/\partial yi1-W\lambda i1 = 0 \quad (3)$$

$$\partial L/\partial Yi2 = \partial U2/\partial yi2-M\lambda i2 = 0 \quad (4)$$

According to (1) and (2), you can first find W and M, substitute (3) and (4), and sort out:

$$\partial U1/\partial Yi1 = (\lambda i1/\lambda a1)(\partial U1/\partial Ya1)$$

$$\partial U2/\partial Yi2 = (\lambda i2/\lambda a2)(\partial U2/\partial Ya2)$$

$$(\partial U1/\partial Yi1)/\lambda i1 = (\partial U1/\partial Ya1)/\lambda a1 \quad (5)$$

$$(\partial U2/\partial Yi2)/\lambda i2 = (\partial U2/\partial Ya2)/\lambda a2 \quad (6)$$

Namely:

Marginal utility of non-farm income / Cost rate of non-farm income = Marginal utility of agricultural income / Cost rate of agricultural income (7)

When satisfied, labor transfer from rural to the city can achieve an optimal state.

3. Econometric Models and Empirical Analysis

3.1. Data Sources

In this paper, China was selected as a research sample, and the research period was from 1990 to 2020, and all data were obtained from the Statistical Yearbook in China.

3.2. Factors Influencing Rural Labor Transfer

Studying China's factors of rural labor transfer can help solve the problems in urbanization of China. However, in the complex economic environment, there are many factors that affect the transfer of rural labor force, and the importance of each factor can't be directly drawn. Therefore, before the test and analysis, it is necessary to discuss the cost and utility of the transfer of rural labor. This paper selects the following representative factors: rural labor transfer's cost includes monetary cost (the cost of food, clothing, housing and transportation, the cost of finding a job) and non-monetary cost (the time cost of finding a job, the psychological cost of leaving home). The ratio of urban and rural consumption expenditure is regarded as the monetary cost of rural labor transfer; Urban unemployment rate is a non-monetary cost reflecting the transfer of rural labor. The utility of rural labor transfer can be divided into monetary utility (income increase) and non-monetary utility (welfare improvement brought by urbanization). The income difference between urban and rural can be regarded as the monetary utility of rural labor force transfer; Because non-agricultural industries provide employment space for rural labor transfer, the proportion of non-agricultural industries' GDP is selected to reflect the non-monetary utility of rural labor transfer.

3.3. Selection of Indicators

Although the following indicators do not fully cover the factors of rural labor force transfer, they are representative and can be quantified. Through the statistical yearbooks of relevant provinces in China, we can find the per capita consumption expenditure of urban and rural residents in China from 1990 to 2020, and then calculate the ratio of urban and rural consumption expenditure, with the following formula:

Urban-rural consumption expenditure ratio = per capita consumption expenditure of urban and rural residents/per capita consumption expenditure of rural residents.

Secondly, we can find the urban unemployment rate in China from 1990 to 2020; Find the per capita disposable income of urban residents and rural residents in China from 1990 to 2020, and then calculate the income gap ratio between urban and rural. The calculation formula is:

Urban-rural income gap ratio = per capita disposable income of urban residents/per capita disposable income of rural residents.

Find the ratio of non-agricultural GDP to GDP in China from 1990 to 2020; From 1990 to 2020, the rural employees and the primary industry employees in China were found, and the transfer rate of rural labor was obtained by calculation. The calculation formula is:

Rural labor transfer rate = (rural employees-primary industry employees)/rural employees.

Therefore, this paper selects urban-rural consumption expenditure ratio (consumption), urban unemployment rate (unemployment), urban-rural income gap ratio (igap) and the ratio of nonagriculture industrial gross product to GDP (nonagriculture) as explanatory variables of rural labor transfer rate (Y), and makes an empirical analysis by composing time series data from the above explanatory variables and explained variables.

3.4. Model Explanation

The model of lag order f is:

$$Yt = A1yt\text{-}1+A2yt\text{-}2+\ldots+ Anyt\text{-}n+ut,$$

where Y_t is the vector of variables to be tested in K dimension; U_t is the random error, also known as pulse value; $A_1, A_2 \ldots A_n$ are the matrix of parameters to be estimated.

3.5. Smoothness Test

Direct regression of non-stationary series will cause "pseudo-regression", so the unit root test of each variable data is carried out first. ADF test is used to test the unit root of time series data. This demonstration is given by EVIEWS10.0 software. As shown in the table1, through ADF test of variables Y, consumption, unemployment, igap and nonagriculture, Y, consumption, unemployment, igap and nonagriculture are all non-stationary sequences, and the second-order difference rejects the original hypothesis at 1% significant level. Therefore, Y, consumption, employment, igap, nonagriculture are second-order integers, i.e. I(2), at the unit root.

Table 1. Stationarity test

Variable	Type	ADF	P	Conclusion
Y	Trend and intercept	-4.570193	0.0057	stable
consumption	Trend and intercept	-6.311867	0.0001	stable
unemployment	Trend and intercept	-4.895536	0.0026	stable
igap	Trend and intercept	-4.511610	0.0068	stable
nonagriculture	Trend and intercept	-4.630586	0.0052	stable

According to the results shown in Figure 1, all eigenvalues of the established VAR model are in the unit circle, indicating that the established model is stable.

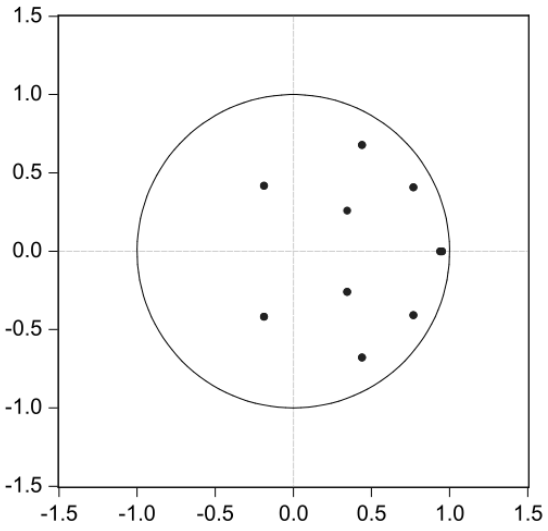

Figure 1. Inverse roots of AR characteristic polynomial

3.6. Impulse Response Function

Impulse response function refers to the influence of one variable on another variable. First of all, to test the stability of VAR model, it can be seen from the data (see Figure 1) that the reciprocal of AR eigenvalue is less than 1, that is, VAR model is stable and impulse response analysis can be conducted. The results of impulse response analysis are seen in Figures 2-4. The vertical axis indicates the change of the growth rate of response variables, the horizontal axis indicates the number of tracking periods of impact, the dotted line indicates the deviation band of plus or minus two standard deviations, and the solid line indicates the impulse response function.

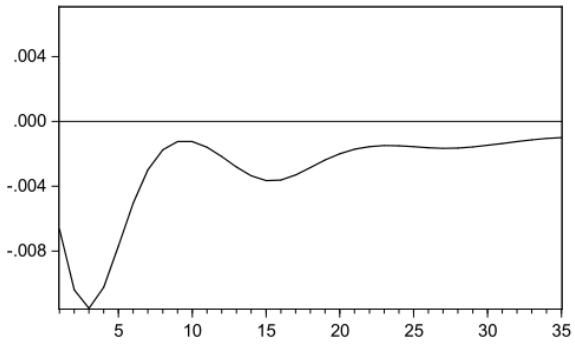

Figure 2. Response of y to consumption

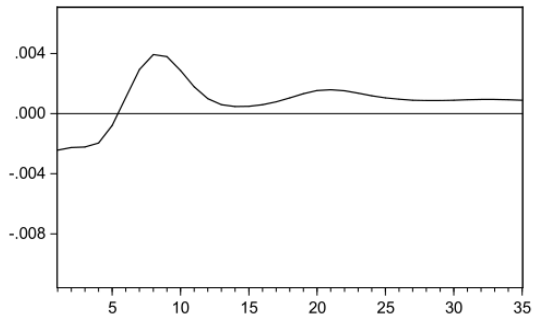

Figure 3. Response of y to unemployment

As can be seen from Figure 2, after a positive role on urban and rural consumption expenditure ratio in this period, the transfer rate of rural labor began to decrease in the first three periods, reached the minimum value in the third period (Y's response to consumption in the third period was -0.0115), then increased, and in the tenth period Y's response to consumption was -0.012, Then it decreased from the tenth period to the fifteenth period (in the fifteenth period, Y's response to consumption was -0.0037). After a big fluctuation in the early period, Y's response to consumption increased slightly from the fifteenth period, and reached a small peak in the twenty-third period (in the twenty-third period, Y's response to consumption was -0.0015), showing a small decreasing trend again, and in the twenty-eighth period, the response decreased to-. This shows that the ratio of consumption expenditure in urban and rural is impacted by external conditions, and then transmitted to the rural labor transfer rate through the market, which brings a certain degree of impact to the transfer rate of rural labor, and this impact has a long-lasting effect and a significant negative effect, and finally gradually converges.

As can be seen from Figure 3, after a positive role on the urban unemployment rate in the current period, there is no change in the current period, but in the first period, Y's response to unemployment is-0.024, and then it starts to increase, and in the fourth period, it reaches -0.002, and it starts to increase all the way to the eighth period (Y's response to unemployment is 0.039), and then it shows a decreasing trend, reaching 0.0 in the fifteenth period. This shows that the registered unemployment rate in cities and towns is impacted by external conditions, and then transmitted to the transfer rate of rural labor through the market, which finally brings a positive impact to the rural labor transfer rate, and this impact has a significant promoting effect and a long-lasting effect.

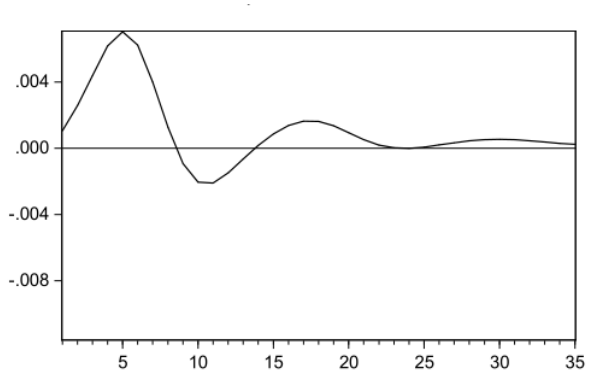

Figure 4. Response of y to igap

As can be seen from Figure 4, after giving a positive impact to the income difference between urban and rural areas in the current period, the transfer rate of rural labor did not respond in the current period, then increased to the maximum value in the fifth period (Y's response to igap was 0.007), and then gradually decreased, reaching the minimum value in the eleventh period (Y's impact on igap was-0.021), showing an increasing trend again, and after the eighteenth period reached 0.016, the rural labor transfer rate increased gradually. This shows that a certain impact of the urban-rural income gap ratio will bring significant positive effects to the rural labor transfer rate. As can be seen from Figure 4, after giving a positive impact to the income gap between urban and rural areas in the current period, the rural labor transfer rate did not respond in the current period, then gradually increased to the maximum value in the fifth period (Y's response to igap was 0.007), and then gradually decreased, reaching the minimum value in the eleventh period (Y's impact on igap was-0.021), showing an increasing trend again, and after the eighteenth period reached 0.016, the rural labor transfer rate increased gradually. This shows that a certain impact of the income gap ratio between rural and urban will bring significant positive effects to the rural labor transfer rate.

As can be seen from Figure 5, after giving a positive impact to the ratio of non-agricultural industrial GDP to GDP in the current period, the labor transfer rate of rural did not respond in the current period, and increased to the sixth period, reaching the maximum value (Y's response to nonagriculture was 0.0019). After that, it gradually decreased, regional stability, and finally converged to 0.007. This shows that a certain impact of the ratio of non-agricultural industrial GDP to GDP will also bring significant positive effects to the rural labor transfer rate.

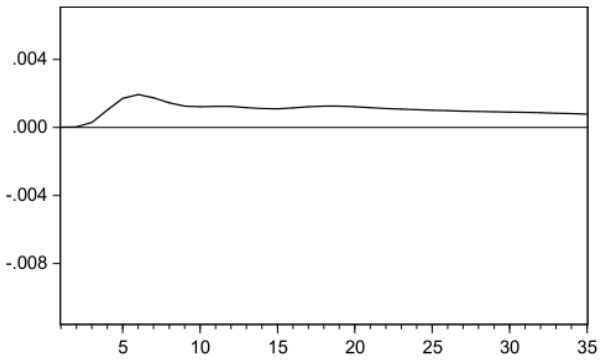

Figure 5. Response of y to nonagriculture

3.7. Variance Decomposition

As can be seen from Figure 6, according to the results of variance decomposition, the contribution degree of consumption to Y shows a trend of increasing at first and then decreasing. The influence degree of the first five periods is constantly increasing, reaching 59% in the fifth period. From the fifth period, the influence degree gradually weakens and finally tends to 49%. Unemployment's contribution to Y gradually decreased in the first six periods, and reached 3% in the sixth period, then began to increase, and increased to 7% in the tenth period. From the tenth period, it gradually increased, and its influence gradually stabilized at 8%. The contribution degree of igap to Y gradually increased from the first period to the maximum value of 19% in the seventh period, then decreased from the seventh period and finally stabilized at 16%. The contribution of nonagriculture to Y shows an increasing

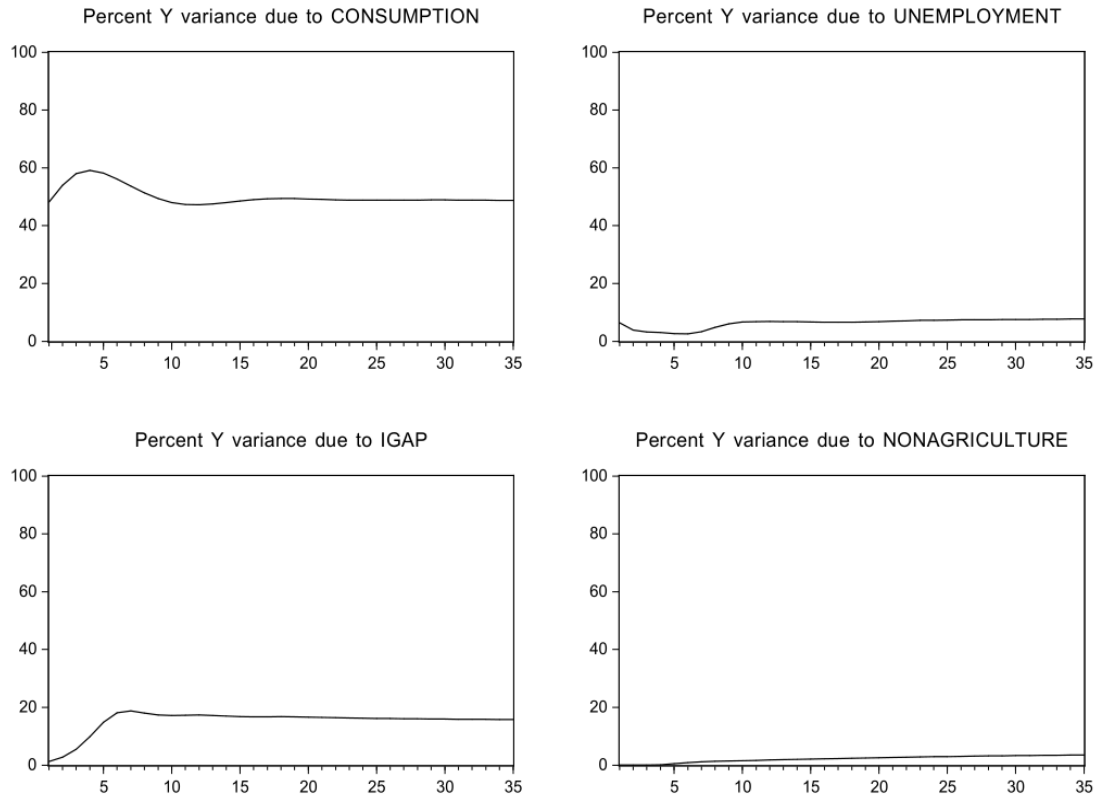

Figure 6. Variance decomposition using Cholesky (d. f. adjusted) factors

trend, and finally tends to 4%. According to the influence degree of the transfer rate of rural labor force from big to small, the influencing factors are ranked as consumption, igap, unemployment and nonagriculture. It can be seen that among all the influencing factors, the ratio of consumption expenditure in urban and rural has the most important impact on the rural labor transfer rate, while the proportion of non-agricultural GDP to GDP has the least impact on the rate of rural labor transfer.

4. Research Conclusions and Policy Recommendations

4.1. Research Conclusions

In this paper, aiming at the influencing factors about rural labor transfer in China, the VAR model is constructed by using the ratio of urban-rural consumption expenditure, urban unemployment rate, urban-rural income difference ratio, the ratio of non-agricultural GDP to GDP and the indicators of rural labor transfer rate. Impulse response function and variance decomposition are used to analyze and test the influence degree of urban-rural consumption expenditure ratio, urban unemployment rate, urban-rural income gap ratio and the ratio of non-agricultural GDP to GDP on rural labor transfer rate. The empirical research results of VAR model show that: according to impulse response function, the ratio of consumption expenditure in urban and rural has a significant negative effect on rural labor transfer rate after being impacted by external conditions; The urban unemployment rate has a positive role on the rural labor transfer rate after being impacted by external conditions; A certain impact of the income difference ratio between urban and rural will bring significant positive effects to the rural labor transfer rate; A certain impact of the proportion of non-agricultural GDP to GDP will also bring significant positive effects to the rate of rural labor transfer. From the results of variance decomposition, it can be seen that among all the influencing factors, the ratio of consumption expenditure in urban and rural has the most significant role on the rural labor transfer rate, while the proportion of non-agricultural GDP to GDP has the least impact on the rural labor transfer rate.

4.2. Policy Recommendations

Based on the results of the above empirical analysis, combined with the reality of the transfer of rural labor in China, this paper puts forward the following countermeasures for reference:

Promoting the effective transfer of labor force from rural to cities by improving the marginal utility of urban non-agricultural income and reducing the cost rate of urban non-agricultural income.

First of all, to improve the marginal utility of urban non-agricultural income, we can discuss it from the perspectives of wage system, social security system, urban construction and urban acceptance of the transfer of rural labor. Improve the wage guarantee system of the transferred labor force, severely punish the behaviors such as wage arrears, delayed payment, etc., and standardize the production and operation behavior of the main person in charge, so that every transferred labor force can receive his or her own wages on schedule. In

addition, most rural laborers will transfer with their families, the most important of which is the problem of transferring rural laborers' children to school, simplifying the school registration procedures in various places, so that the problem of going to school will no longer become the worry of rural laborers' transfer. At the same time, the medical security system should be constantly improved to facilitate rural labor transfer. Furthermore, we can increase local public investment and infrastructure construction, so that rural migrant workers can enjoy the benefits brought by urbanization. The government should give preferential policies to rural migrant workers in all aspects of food, clothing, housing and transportation, so that these groups have a sense of belonging to the city and no longer feel excluded.

To reduce the cost rate of non-agricultural income, it is important to imagine from the perspective of rural labor transfer. Most of these groups have no help from social contacts, and it is hard to solve the overall employment problem of rural labor transfer simply by relying on "local", that is, blood relationship. Therefore, it is necessary to control the information price, optimize the information structure of market search, cooperate with towns and villages, form a complete job information chain from information promulgation to job training, reduce the job search cost of rural migrant workers, and at the same time, reduce the possibility that some rural migrant workers are deceived by black intermediaries. The government should also improve the market competitiveness of migrant workers in rural from the aspect of education, adjust the training content of migrant workers in rural in time according to the changes of supply and demand in labor market, better meet the market demand, and solve the problem of difficult employment of migrant workers in rural area. In short, the above policies are given from two aspects: increasing the marginal utility of non-agricultural income in urban and reducing the cost rate of urban non-agricultural income. Finally, the marginal utility of non-agricultural income in urban is equal to the cost rate of urban non-agricultural income, and the optimal state of the transfer of rural labor to cities and towns is realized.

Under the strategy of rural revitalization, villages can also cultivate their own industries and realize local urbanization.

On-the-spot urbanization can promote the modernization of agriculture and rural. While accommodating the transferred labor force, it attracts a lots of labor to return, and the countryside will no longer decline. This not only solves the homesickness problem of the transferred labor force, but also solves all kinds of problems brought by the transfer of rural labor to urban construction. At present, big cities are getting bigger and bigger, and "urban diseases" such as blocking, haze and waterlogging are increasingly challenging people's tolerance limits. Contradictions and conflicts in urban management are becoming more and more prominent, urban land resources are increasingly scarce, but the demand for construction land is increasingly strong. Social conflicts and even confrontations caused by land requisition and demolition are becoming more and more difficult to resolve. Most importantly, the gap between agricultural and rural modernization and industrialization and urbanization is not narrowing, but further widening. If the above-mentioned contradictions are not resolved, the rural revitalization strategy will not be realized, and the urbanization

transformation will not be completed. However, local urbanization is just a solution, giving play to the functions of the villages themselves, realizing that the villages are the bottom of the urban economy and injecting new vitality into the economic development of China.

Conflict of interest: none.

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The Impact of E-commerce on Farmers' Income A Propensity Score Matching Analysis in Mei County, China

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Abstract: This research examines the impact of e-commerce adoption on the rise of farmers' income using household survey data from kiwifruit growers in Mei County, Shaanxi Province and the propensity score matching technique (PSM). According to the study's findings, the adoption of electronic commerce has a positive effect on farmers' income. Further, capital accumulation appears to have a remarkable impact on the income-increasing impact of e-commerce adoption, and different capital stocks will result in varying income-increasing effects. Accordingly, the government should attach importance to the decisive role of e-commerce, help farmers establish a stable sales network to improve the income of farmers and enhance the quality of their life.

Keywords: interpersonal trust e-commerce; PSM; social capital; farmers' income

JEL Classification: O13; Q12

1. Introduction

With the rapid growth of the Internet in recent years, e-commerce as a new method of selling has made a significant influence on people's lives. According to the Statistical Report on China's Internet Development, the number of Internet users in China surpassed 900 million by the end of 2019, with 99.3 percent using mobile phones, and 700 million online shoppers. Among them, there are 255 million Internet users reside in rural areas, laying the groundwork for the rapid growth of "Internet plus agriculture". China's rural internet retail sales hit 205 million in 2021, and rural e-commerce penetration is growing.

Due to the convergence of information technology and agricultural development, agriculture e-commerce is inevitable. In recent years, the favorable influence of e-commerce on rural economies has increased. Developing agricultural e-commerce is a crucial step in fostering the advancement and transformation of rural industries worldwide. At the micro level, e-commerce can break the long-term structure of information asymmetry (Song et al., 2022) and expand the range of consumers' choices (Hu et al., 2022).

At present, there are two kinds of e-commerce models widely used in agricultural products market: "platform e-commerce" and "interpersonal trust e-commerce". Taobao is a typical example of the first one. With rather sophisticated technology, Taobao's e-commerce infrastructure includes a user feedback system, an appeal and arbitration system, dependable third-party services, and Alipay, a secure payment system (Li & Chua, 2016). In contrast, the second type is mainly based on interpersonal trust represented by WeChat business

(accounting for about 90 percent of this type). WeChat is one of the least technically demanding businesses in the e-commerce business model. It breaks the platform fees charged by three parties and relies more on individual social networks and interpersonal trust. Compared with traditional rural market transactions, it has a wider scope and wider market audience (Hu et al., 2022), and individuals and merchants can carry out business with a small cost (Li, 2020). The "E-commerce Law of the People's Republic of China" went into effect on January 1, 2020, and WeChat commercial industry was formally included in the scope of network supervision. This means that WeChat business will gradually normalize and legitimize (Zhuang & Chen, 2020). Therefore, the development of WeChat business of agricultural products is an inevitable trend (Wang & Zhou, 2016).

Nevertheless, most of the existing literature involves market research and policy research, and micro empirical analysis is lacking. Therefore, this article focuses on the impact of WeChat operation on farmers' income, which is innovative to a certain level. In this work, the PSM method, which is extensively employed in the study of agricultural micro effect analysis, is chosen to examine the effect of WeChat business on farmers' income. It is widely employed to address the issue of selection bias and biased estimates resulting from "self-selection" of samples, such as Li et al. (2021); Li et al. (2017).

The goal of this article is to investigate the income-enhancing effect of WeChat business on farmers, including total revenue and revenue per capita, and to test the difference of income increasing effect under different capital ownership. Specifically, the PSM matching approach is used to quantify the influence of WeChat operation on farmers' income growth by matching the number of the family labor force, kiwifruit planting experience, health status, cultivated area, family prestige, social network, the main source of family income, whether family members are leading cadres, whether they are kiwifruit planting demonstration households and whether they actively collect wealth information. In terms of research of increasing effect of income difference, we use physical capital, human capital, and social capital as grouping variables to study.

The section 2 provides an overview of the PSM approach, data sources, and variable selection in this paper. The empirical results, stationary test, and sensitivity analysis are presented in the section 3. And section 4 gives some conclusions and enlightenment.

2. Method Data and Variables

2.1. Empirical Methods

In this research, the PSM approach is used to examine the influence of e-commerce sales on the income of farmers, and the following measuring model is developed:

$$Y_i = \alpha + \delta D_i + \beta X_i + \varepsilon_i \quad (1)$$

Where i refers to different farmers; Y_i refers to farmers' agricultural income; D_i is a dummy variable indicating whether to use e-commerce for purchasing and selling activities. If i is an adopter, D = 1, otherwise, D = 0; X is a vector of other additional explanatory

variables; α is the constant term, and ε_i is the random interference term. The symbol δ represents the income impact of e-commerce adoption.

Propensity score matching (PSM) is the primary strategy for addressing the issue of self-selection. In this study, we will apply the PSM approach to address the self-selection problem of farmers' adoption of e-commerce, which is based on a sample of farmers who do not engage in e-commerce. Each e-commerce farmer is paired with a non-e-commerce farmer whose attributes are similar to those of the e-commerce farmer except for differences in e-commerce adoption behavior. Consequently, the result variables of two sample subjects can be views as the outcomes of two distinct experiments conducted by the same farmer (adopting e-commerce and not adopting e-commerce). The difference between the outcome variables represents the net effect of the adoption of e-commerce. The net effect for the entire group of e-commerce farmers is known as the average treatment effect of the treated (ATT), and its expression is:

$$ATT = E(Y_1|D = 1) - E(Y_0|D = 1) = E(Y_1 - Y_0|D = 1) \quad (2)$$

Where Y_1 represents the amount of agricultural income following the adoption of e-commerce, and Y_0 refers to the agricultural income level when the farmers do not adopt e-commerce. Only $E(Y_1|D = 1)$ can be observed; $E(Y_0|D = 1)$ is an unobservable counterfactual result, so it is necessary to use the PSM method to construct its alternative index.

PSM is mainly based on observable explanatory variables and the unobservable factors that affect decision variables do not play a direct role. If the observable variables are not set correctly, the unobservable characteristics will lead to biased estimation of tendency score and wrong sample matching (Heckman & Navarro-Lozano, 2004). In this paper, the sensitivity analysis method proposed by Rosenbaum (2002) was used to test the influence of unobvious factors. Because the method is difficult to directly measure the potential bias error, that is, to assess the sensitivity of a set of unobservable factors to a change in the magnitude of action of the probability of treatment.

We also categorize farmers using PSM to explore the variations between groups in terms of the impact of e-commerce adoption. Group comparisons in PSM were used to study the differences in the treatment effect among groups. There is no lack of precedents in academic circles, such as Li et al. (2021). In this paper: according to the grouping variables (material capital, human capital and social capital), the total sample is first divided into several subsamples; next, PSM analysis is carried out for each subsample; ultimately, ATT of each sub-sample is obtained, and the difference between groups is analyzed.

2.2. Data Source

In January 2020, kiwifruit farmers in Mei County, Baoji City, Shaanxi Province were surveyed as part of a household survey for the purposes of this paper. Kiwifruit in Mei County is a geographical indication product of agricultural products of the Ministry of Agriculture, which has been selected into China's agricultural brand catalogue, with a brand value of 12.833 billion yuan. By the end of 2019, the planting area of Kiwifruit in Mei County has reached 302 thousand mu (one-seventh of China's total kiwi planting area), with kiwifruit

production covering all administrative villages in Mei County. Farmers in the county have planted 4.5 mu kiwifruit per household on average, 1.16 mu per capita, and there are more than 120 thousand kiwifruit employees. (In China, "mu" is the municipal land area unit. One mu is equivalent to 60 square abbot, roughly 666.667 square meters.) The total output is 495 thousand tons, the output value of fresh fruit is 3.1 billion yuan, and the overall output value is 5.2 billion yuan. Kiwifruit has become the pillar industry for farmers to increase their income and become rich in Mei County.

To meet research needs, we limited the selected survey object to kiwifruit growers in Mei County. In December 2019, 8 undergraduates conducted a one-week face-to-face survey in Mei County. We selected 7 villages for investigation on consideration of the distance from the center of the county. In each village, researchers are required to randomly visit 3 WeChat business farmers and 6 non-WeChat business farmers. Theoretically speaking, the number of non-WeChat business farmers is larger than that of WeChat farmers, which is more conducive to the success of sample matching (Li et al., 2021). Therefore, a total of 504 questionnaires were distributed, consisting of 168 surveys to WeChat business farmers and 336 questionnaires to non-WeChat business farmers. After eliminating the questionnaires with missing data and extreme values, the sample size of PSM analysis is 138 WeChat farmers (82.1% efficiency), 290 non-WeChat business farmers (86.3% efficiency), a total of 428 (84.9% overall efficiency).

2.3. Descriptive Analysis

Before giving descriptive analysis, it is crucial to describe the most significant variables utilized in the study. The study's primary variable, farmer income, was measured by gross income or per capita income. Total revenue refers to the sum of kiwi fruit sales through and outside of WeChat platforms by households in 2019. And per capita income refers to the kiwi sales income per household member in 2019 and is calculated by dividing the total household income in 2019 by the quantity of household members participating in the industry.

For the matching variables of PSM, this paper adopts the selection idea based on the theory and previous experience research, guided by the matching effect. The final selected matching variables include the number of family labor (Zhou, 2013), kiwifruit planting experience (Tang & Zhou, 2018; Tang, 2017), the main source of family income, whether family members are leading cadres (Zeng et al., 2019), whether they are kiwifruit planting demonstration households, family cultivated area (Tang & Zhou, 2018), and health status (Tang & Zhou, 2018), family prestige (Tang, 2017) and social network (Tang & Zhou, 2018). Family prestige refers to the individual perception of the family's prestige in the village, and a social network refers to whether the farmers are willing to expand their social network actively. Specifically, the variable Y_1, which represents the average total income of sample farmers, is 51,757.53 yuan. The variable Y_2, which represents per capita income, is 11,127.53 yuan.

Table 1 displays the descriptive analysis findings for all variables. The samples are divided into WeChat business adopters and WeChat business non-adopters. It can be seen that in the result variable, the total income of the adopters is 76,395.80 yuan, and the per capita income is 16,623.17 yuan. The adopters were 36,322.40 yuan and 8,101.81 yuan more than the non-adopters. Then it comes to matching variables, the two groups of farmers

showed remarkable differences in kiwifruit planting experience, social network, the main source of family income, whether family members are leading cadres, whether they are kiwifruit planting demonstration households, the cultivated area, and health status. However, there is no statistically significant difference between farmers who utilize e-commerce and those who do not in terms of family prestige and labor force size.

Table 1. Descriptive statistics of variable differences

Variable type	Variable name	E-commerce adoption		Non-adoption		Mean difference (T test)
		Mean	S.D.	Mean	S.D.	
Outcome variables	Total revenue	76,395.80	9,088.34	40,073.40	1,622.61	-5.44***
	Revenue per capital	16,623.17	2,151.64	8,521.36	377.65	-5.13***
Matching variables	Kiwifruit planting experience	13.56	0.52	12.05	0.37	-2.32**
	Social network	0.72	0.04	0.57	0.03	-2.88***
	The main source of family income	1.41	0.10	1.16	0.04	2.61***
	Whether there are leading cadres	0.12	0.03	0.05	0.01	-2.41**
	Demonstration household or not	0.12	0.03	0.06	0.01	-2.33**
	Cultivated area	5.09	0.27	4.54	0.11	-2.19**
	Health status	3.93	0.06	3.79	0.05	-1.85*
	Family prestige	3.33	0.09	3.27	0.05	-0.52
	The number of family labor	2.90	0.09	2.74	0.06	1.58

Note: *, **, and *** are significant at the levels of 10%, 5%, and 1%, respectively.

3. Analysis of Empirical Results

3.1. Farmers' Estimation of the Adoption Choice Equation for Interpersonal Trust E-commerce

Table 2 displays the estimation results of the Logit model. It can be seen that social networks, the main source of family income, whether there are leading cadres in the family, family prestige, and cultivated area significantly affect the adoption of interpersonal trust e-commerce. In addition, although the regression coefficient is positive, the kiwifruit planting experience, the number of the family labor force, whether it is a planting demonstration household and the health status have not passed the significance test.

Table 2. Logit model-based estimation of the adoption decision equation for e-commerce

	Coefficient	Standard error	Z statistic
Kiwifruit planting experience	0.03	0.02	1.64
Social network	0.64**	0.26	2.48
The main source of family income	0.32***	0.11	2.86
Whether there are leading cadres	0.91**	0.42	2.18
Family prestige	0.25 *	0.14	-1.85
The number of family labor	0.11	0.11	0.98
Demonstration household or not	0.71	0.38	1.88
Cultivated area	0.06 *	0.05	1.23
Health status	0.20	0.15	1.31
Constant term	-2.59 ***	0.73	-3.53
Pseudo R2	0.0633		
LR statistics	34.07		
Sample capacity	428		

Note: *, **, and ***are significant at the levels of 10%, 5%, and 1%, respectively.

3.2. Balance Test

There will inevitably be a "shared support region" overlap between the propensity scores of WeChat business farmers and non-WeChat business farmers. The probability of sample loss decreases as the extent of the standard support domain increases. In order to make the best use of the samples of WeChat farmers, different matching methods will produce different sample loss. In this study, we select four matching algorithms: nearest neighbor matching (1:1 matching), nearest neighbor matching (1:2 matching), kernel matching (window width = 0.06), and kernel matching (window width = 0.09). Among the above four matching methods, the sample loss of WeChat farmers is minimal, so the common support domain condition is satisfactory.

The results of the balance test for explanatory factors before and after matching are shown in Table 3. As can be seen, the standard deviation of most explanatory variables after matching has been dramatically reduced. For all explanatory variables, it was within 10%. After matching, there was no significant difference in all explanatory variables between the treated and the controlled. As can be seen from Table 3, the pseudoR2 value decreased from 0.064 before matching to 0.001–0.012 after matching. LR statistics decreased from 34.31 before matching to 0.31-4.64 after matching. The joint significance test of explanatory factors went from being highly significant to being consistently rejected at a threshold of 10%. From 20.6% to 1.6–6.4%, the mean deviation of explanatory factors decreased. The median deviation was reduced from 22.5% to 1.2–6.0% and the total deviation was also significantly reduced. The aforementioned test findings indicate that inclination score estimation and sample matching are successful, and that matching WeChat adopters are comparable to non-adopters.

Table 3. Balance test results of explanatory variables before and after matching

Matching method	Pseudo R2	LR statistics	P-value	Mean difference (%)	Median difference (%)
Before matching	0.064	34.31	0.00	20.6	22.5
Nearest neighbor matching (1:1 matching)	0.012	4.64	0.87	6.4	6.0
Nearest neighbor matching (1:2 matching)	0.006	2.45	0.98	4.8	3.8
Kernel matching (window width = 0.06)	0.001	0.31	1.00	1.6	1.2
Kernel matching (window width = 0.09)	0.002	0.68	1.00	2.6	2.2

3.3. Measurement Results of Income Increasing Effect of Interpersonal Trust E-commerce Adoption by Farmers

Table 4 reports the total revenue, revenue per capita, and ATT value of the treated and the controls by using four matching methods, respectively. Consequently, the results produced using various matching approaches are fairly similar, and the 1% significance test has been passed for the ATT value of total revenue and revenue per capita. Due to the implementation of WeChat business, per capita income and total income increased by 7,497.3 and 33,744.21 yuan, respectively. The increase in revenue per capita income accounts for

Table 4. The measurement results of income increasing effect

Matching method	Revenue per capita (yuan)			Total revenue(yuan)		
	Treated	Controls	ATT	Treated	Controls	ATT
Before matching	16,623.17	8,525.91	8,097.25***	76,395.80	40,112.27	36,283.53***
Nearest neighbor matching (1:1 matching)	16,623.17	9,545.69	7,077.48***	76,395.80	42,539.49	33,856.31***
Nearest neighbor matching (1:2 matching)	16,623.17	9,343.52	7,279.64***	76,395.80	42,661.23	33,734.58***
Core matching (window frame = 0.06)	16,616.97	8,778.72	7,838.26***	75,805.66	42,003.51	33,802.15***
Core matching (window frame = 0.09)	16,616.97	8,820.61	7,796.36***	75,805.66	42,221.87	33,583.79***
Mean value	16,620.07	9,122.14	7,497.93	76,100.73	42,356.52	33,744.21

Note: *, **, *** are significant at the level of 10%, 5% and 1% respectively; the significance test results of ATT value are obtained by self-service method.

82.19% of the total revenue of non-adopters, and the increase in total revenue accounts for 79.67% of the total revenue of non-adopters. Hence one can see that the adoption of WeChat business can markedly improve the revenue per capita and total revenue.

The research findings indicate that the implementation of e-commerce based on interpersonal trust can boost the agricultural revenue of farmers. Farmers who accept interpersonal trust e-commerce have a greater income per capita and total revenue than those who do not. The new development of rural e-commerce is gradually making it possible for Chinese farmers to share digital dividends. Interpersonal trust e-commerce is also gradually increasing the income of farmers.

Table 5. Sensitivity analysis of total income ATT of WeChat business farmers

Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1.0	0.000	0.000	16,690.0	16,690.0	9,606.00	24,960.0
1.1	0.000	0.000	15,014.5	18,455.1	7,847.25	26,975.0
1.2	0.000	0.000	13,214.5	20,410.0	6,223.50	28,930.0
1.3	0.001	0.000	11,830.0	22,180.0	4,720.00	30,696.5
1.4	0.002	0.000	10,575.0	23,650.0	3,400.00	32,395.0
1.5	0.006	0.000	9,200.0	25,260.0	2,070.00	34,330.0
1.6	0.013	0.000	8,145.0	26,595.0	1,000.00	36,125.0
1.7	0.026	0.000	7,114.5	27,818.5	-100.00	37,862.3
1.8	0.047	0.000	6,125.0	29,083.5	-1,150.00	39,600.0
1.9	0.078	0.000	5,315.0	30,200.0	-1,945.00	41,125.0
2.0	0.118	0	4,210.0	31,259.6	-2,950.00	42,517.0
2.1	0.168	0	3,423.5	32,345.0	-3,750.00	44,107.0
2.2	0.228	0	2,650.0	33,494.5	-4,600.00	45,553.5
2.3	0.294	0	1,895.0	34,637.0	-5,504.00	47,150.0
2.4	0.364	0	1,200.0	35,650.0	-6,165.00	48,750.0

3.4. Sensitivity Analysis

Table 5 displays the results of a sensitivity analysis comparing the rate of WeChat business adoption to total income, where the gamma coefficient indicates the impact of overlooked factors on adoption of interpersonal trust e-commerce by farmers. If the conclusion is not statistically significant when the gamma coefficient is close to 1, the PSM

result cannot stand up to examination. If the conclusion is not statistically significant when the gamma coefficient is large (often close to 2), then the PSM result is acceptable (Rosenbaum & Rubin, 1983). As can be seen, when the gamma coefficient increases to 1.9, the existing conclusions become insignificant at the level of 0.05. Logically, it is possible to claim that projected revenue based on PSM technology is insensitive to unobtainable elements, which mitigates our fear that unobtainable factors may have a large impact on estimated revenue.

3.5. An Analysis of the Difference of the Effect of Increasing Income on the Adoption of Interpersonal Trust E-commerce by Farmers

According to the analysis and forecast of China's economic situation in 2016, China's urban-rural income gap has narrowed, but the rural internal income gap has widened (Li et al., 2018). In the same location and sector, social capital, physical capital, and human capital will influence the income-enhancing effect of e-commerce adoption among farmers, resulting in income-enhancing effects of e-commerce that vary among farmers (Zeng et al., 2019). This article studies the difference in the income-increasing effect of the adoption of interpersonal trust e-commerce in rural families in an effort to ameliorate the phenomena of the rising income gap in rural areas, narrow the digital divide, and also reduce the income gap.

For the variables used for PSM group comparison, we use the cultivated area to reflect the material capital factors (Xia & Zhang, 2018); frequency of learning sales skills to reflect human capital factors (Deng & Xia, 2019; Tang, 2017); expenses for gifts, the number of mobile phone contacts and family prestige represent social capital factors (Tang, 2017; Zeng et al., 2019; Tang & Zhou, 2018). The frequency of learning sales skills refers to the frequency of farmers actively searching and learning sales skills, expenses for gifts refer to the gift money that farmers spend every year due to relatives' and friends' weddings and funerals during the past three years. The number of mobile phone contacts refers to the main kiwifruit sales publicists of the family.

Due to the small sample size, we divide all data into two groups for each grouping variable in order to assure the matching effect. For continuous grouping variables, we first calculate their mean value and then divide them into two sample groups "greater than the mean value" and "less than or equal to the mean value" for PSM.

According to existing knowledge, for agricultural income, the land owned by farmers is the essential physical capital and carrier for planting and harvesting. The amount of land owned directly affects the income of farmers (Xia & Zhang, 2018). For this reason, we select the cultivated area to reflect the factors of physical capital, and group it according to the above-average level and below or equal to the average level to study the difference of income increasing effect. In addition, human capital investment in education and training can increase the accumulation of human capital, improve the scientific and cultural literacy of workers, improve agricultural labor productivity and promote the growth of farmers' income (Huang, 2005; Deng & Xia, 2019). Accordingly, we select the frequency of daily learning sales skills to reflect the human capital factors of farmers and divides them into never or general and positive or more positive groups according to the learning frequency to study the difference of income increasing effect.

In addition, maximizing the information advantages of traditional social capital, for example, blood relationship and geographical relationship network, can increase the income of farmers and encourage the growth of rural economies (Liu, 2018; Tang & Zhou, 2018). Therefore, we choose expenses for gifts, mobile phone contacts, and family prestige to measure social capital factors. They were compared according to the above-average level and below or equal to the average level in order to explore the difference of income increasing effect of interpersonal trust e-commerce.

Table 6 reveals that after the adoption of WeChat business, farmers whose cultivated area is higher than the average increase by 10,869.49 yuan and 40,996.00 yuan in per capita sales income and total income respectively; and yet farmers whose cultivated land area is lower than or equal to the average increase 5,454.19 yuan and 27,584.59 yuan in per capita sales income and total income respectively. It can be deduced that household cultivated area has a substantial favorable influence on the effect of implementing WeChat business on raising income.

For families with more cultivated land, the main source of their income is agricultural income. Undoubtedly, they will invest more labor force in agricultural production, which makes the effect of increasing income more significant. For the frequency of learning sales skills, after adopting WeChat business, farmers who actively learn sales skills increase 11,639.52 yuan and 49,921.20 yuan in revenue per capita and total revenue, respectively. However, others only increased by 6,033.60 yuan and 25,757.71 yuan, respectively.

As for the number of mobile phone contacts, the results show that after the adoption of WeChat business, farmers whose mobile phone contacts are more than the average increase by 10,520.6 yuan and 54,037.72 yuan revenue per capita and total revenue respectively. By comparison, others only increased by 6,614.14 and 24,461.17 yuan, respectively. Consequently, the number of mobile phone contacts has a substantial beneficial influence on the growth of WeChat's commercial revenue. In China's rural society, the main way of communication and exchange is also telephone contact. That is to say, to some extent, the number of mobile phone contacts can reflect the scope of farmers' access to information and the level of their ability to access information. The more comprehensive information access channels and information there are, the more favorable they are to farmers' knowledge of e-commerce sales channels, so encouraging farmers to sell agricultural goods via interpersonal trust e-commerce sales channels and enhancing family income.

In terms of family prestige, the results show that after adopting WeChat business, farmers with higher family prestige increase by 8,359.53 yuan and 40,529.59 yuan in revenue per capita and total revenue respectively, and yet farmers with lower family prestige only increased 7,667.54 yuan and 28,311.69 yuan, respectively.

In terms of expenses for gifts, the results show that after adopting WeChat business, farmers whose gift expenses are higher than the average increase by 12,847.01 yuan and 54,132.32 yuan in revenue per capita and total revenue respectively. However, others increased by only 4,766.49 yuan and 22,278.71 yuan, respectively. Evidently, family prestige and expenditures for presents have large beneficial effects on the revenue growth of WeChat

businesses, indicating that the relationship social capital based on blood and location still plays an important role in the rural areas of our nation.

Physical capital, human capital, and social capital considerably influence the income-increasing effect of farmers' adoption of interpersonal trust e-commerce, as determined by the PSM group comparison. Nonetheless, the wealth disparity within the farmer group will always exist. It can even be said that the application of information technology, represented by e-commerce, has become an essential source of income gap within farmers to a certain extent.

Table 6. Influencing factors of income increasing effect difference of e-commerce adoption

Variable	Grouping	Revenue per capita			Total revenue		
		Treated	Controls	ATT	Treated	Controls	ATT
Cultivated area	＞Mean	22,144.49	11,274.99	10,869.49***	97,626.15	56,630.15	40,996.00***
	≤Mean	12,142.00	6,687.81	5,454.19***	57,748.33	30,163.75	27,584.59**
Learning sales skills	Positive	21,014.78	9,375.26	11,639.52**	93,448.78	43,527.58	49,921.20**
	Negative	14,468.38	8,434.78	6,033.60***	66,836.15	41,078.43	25,757.71***
Phone contacts	＞Mean	18,454.41	7,933.81	10,520.60***	93,491.73	39,454.00	54,037.72**
	≤Mean	15,979.69	9,365.55	6,614.14***	67,774.36	43,313.20	24,461.17***
Family prestige	＞Mean	17,484.45	9,124.92	8,359.53**	85,442.74	44,913.14	40,529.59**
	≤Mean	15,883.02	8,215.49	7,667.54**	66,286.12	37,974.42	28,311.69***
Expenses for gifts	＞Mean	22,002.87	9,155.86	12,847.01***	96,954.08	42,821.76	54,132.32***
	≤Mean	13,499.99	8,733.49	4,766.49**	63,557.35	41,278.64	22,278.71***

Note: *, **, and *** are significant at the levels of 10%, 5%, and 1% respectively.

4. Conclusion and Enlightenment

This research offers empirical evidence that e-commerce can increase the revenue of farmers.

The results indicate that the adoption of electronic commerce based on interpersonal trust can substantially raise and boost the revenue of farmers. Also, the different capital endowments of farmers result in differences in income increasing effect. Based on survey data of kiwifruit farmers in Mei County, Baoji City, Shaanxi Province in January 2020, we have demonstrated that e-commerce platforms may be used to increase and promote the income of farmers.

In China, the development of rural interpersonal trust e-commerce is a crucial aspect of agricultural modernization, as it optimizes the production, sales, and circulation of agricultural goods and promotes the growth and expansion of the rural economy. In addition, farmers should teach themselves how to acquire information, particularly regarding e-commerce sales. And in this process, to reinforce and increase the understanding of e-commerce behavior involvement. To encourage the growth of a paradigm of e-commerce based on interpersonal trust in rural areas. This is the only method for farmers to directly reap the income-boosting benefits of e-commerce. What's more, social capital, as significant as physical capital and human capital, must be paid more attention to the impact of interpersonal trust e-commerce behavior of farmers. In addition to maximizing the benefits of existing social networks, we should also mobilize more comprehensive social resources with the aid of modern social capital, introduce new technology, and increase farmers' income.

Conflict of interest: none.

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The Impact of Fiscal Spending on Science and Technology on the Development of the Digital Economy

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Abstract: The digital economy is becoming a new driving force for global economic development. According to the UN report, China has the second largest digital economy in the world. In the face of new challenges brought by the digital economy, China is committed to innovation-driven development and promotes high-quality development of the digital economy. Fiscal investment in science and technology can promote scientific and technological innovation, which plays a vital role in the digital transformation of enterprises and the promotion of digital economic infrastructure construction. The main aim of the paper is to study the impact path of fiscal investment in science and technology on digital economy by taking China as an example. The research uses China's 2013-2021 digital economy development index and intensity of fiscal investment in science and technology to empirically test the impact of fiscal investment in science and technology on the development of digital economy. The study found that fiscal spending on science and technology promotes enterprises' digital technology innovation and digital infrastructure, thus motivating the innovative development of digital economy.

Keywords: fiscal investment of science-and-technology; digital economy; innovation

JEL Classification: E62; L86; H50

1. Introduction

The term "digital economy" was first coined by Tapscott (1996), who in his book *The Digital Economy: Promise and Peril in the Age of Networked Intelligence* first defined the economic model of presenting information flows digitally as "digital economy". Literally, the digital technology economy is the foundation of the digital economy. Since the development of the early digital economy is closely related to the Internet, the digital economy is also called the Internet economy. Subsequently, the digital economy is generally understood as the economic activity generated by the flow of data and information through networks. The definition of a thing always reflects times and trends it appears. In the 1990s, the Internet was the mainstream technology, and the early definition of "digital economy" was also mainly related to the Internet. Later, with the innovative development of mobile and sensor networks, cloud computing and big data, new technologies have been added to the definition of the digital economy. Nowadays, if the digital economy is to achieve sustainable and high-quality development, technological innovation cannot be ignored. The digital economy is the most dynamic area of innovation, and innovation is an important driving force for the high-quality development of the digital economy.

Messina (2018) points out that the digital economy is not uniquely driven by technology, it also requires adequate, flexible, and low-cost Information Systems. The development of digital economy is highly dependent on positive external products such as digital infrastructure and enterprise digital technology innovation. Sturgeon (2021) argues that rich countries or poor countries, big companies or small companies can increasingly rely on new, often low-cost or free, digital economy tools to improve organizational efficiency, accelerate the development of new products, and support the upgrading of the digital economy. The tool of fiscal expenditure on science and technology has such an effect. In the absence of government intervention, the marginal private income of digital infrastructure construction and enterprise digital technology innovation is lower than the marginal social income and the marginal private cost is higher than the marginal social cost, which cannot realize the optimal allocation of resources by the market, resulting in insufficient investment in digital infrastructure construction, the lack of enterprise innovation motivation and the loss of social welfare. In order to realize the improvement of pareto, our country can "compensate" for the loss of social welfare through fiscal spending, and provide long-term and effective fiscal support for digital infrastructure construction and digital technology innovation, thus increasing the allocation of resources to digital infrastructure construction and digital technology research and development.

Among them, the fiscal expenditure on science and technology can effectively reduce the cost of digital transformation of enterprises and drive them to accelerate the pace of innovation (Kleer, 2010). The support of financial expenditure on science and technology can help enterprises alleviate financing difficulties and increase investment in digital transformation. Through direct fiscal support (fiscal subsidies, fiscal interest discounts, etc.), the government selects high-efficiency and high-potential enterprises that meet the funding conditions and provides funds to these enterprises (Howell, 2015) to improve their fiscal conditions (Czarnitzki et al., 2011). Therefore, fiscal investment in science and technology can promote the innovation of digital technology, then have an impact on the development of digital economy.

On the other hand, the fiscal expenditure on science and technology can bring the whole industrial chain of digital infrastructure construction into the direction of development fund support. Then precisely support the construction of digital infrastructure projects and promote the comprehensive development of its construction. (Lin, 2019) The quantity, quality and price of digital infrastructure determine the speed and height of digital economy. Therefore, fiscal investment in science and technology can promote the construction and innovation of digital infrastructure, thus promote the high-quality development of the digital economy.

Based on previous studies of scholars and my own reasoning hypothesis, the main goal of this paper is to test the impact of fiscal investment in science and technology on the innovation and development of digital economy and its action path.

2. Methodology

The main purpose of this paper is to examine the impact path of fiscal investment in science and technology on digital economy. The impact of fiscal expenditure in science and technology on digital economy is reflected in digital technology innovation and digital

infrastructure. Fiscal investment in science and technology plays a significant role in enterprises' scientific and technological innovation. At the same time, fiscal investment in science and technology plays an important role in promoting the development of digital economy infrastructure. Both technological innovation and digital economy infrastructure are likely to have an impact on the development of the digital economy. Based on the above analysis, hypothesis is put forward in this paper:

H: fiscal science and technology expenditure has a positive promoting effect on the high-quality development of digital economy.

The data of fiscal science and technology expenditure in this paper are from China Statistical Yearbook. Based on the connotation of digital economy, this paper adopts the CRITIC method to construct the development level index of digital economy (Report on China's Digital Economy Development Index, 2021). The evaluation system of digital economy development index is shown in Table 1. Based on this standard, the digital economy development index from 2013 to 2021 can be calculated.

Table 1. The evaluation system of digital economy development index

Level 1 metrics	Level 2 metrics	Level 3 metrics	Raw metrics
Digital Economy Development Index	Digital infrastructure	New infrastructure	number of supercomputing centers
			number of data centers
			number of data exchanges
		Data elements	the number of data element enterprises
			proportion of enterprises with data elements
		Auxiliary enterprises	number of ancillary businesses
			proportion of auxiliary enterprises
	Digital technology	Digital technology companies	digital technology enterprise investment
			digital technology business operations
			digital technology enterprise output
		Digital technology innovation	passion for digital technology innovation
			the effectiveness of digital technology innovation

3. Results

Based on the above analysis, the following model is designed to test the hypothesis:

$$y_t = \beta_0 + \alpha_1 x_t + \alpha_2 lnpop_t + \alpha_3 lneopen_t + \alpha_4 lnfainv_t + \varepsilon_t \quad (1)$$

In Formula (1), the subscript t represents time (year), the explained variable y_t is the development level index of digital economy, and the explanatory variable x_t is the intensity of government spending on science and technology, which is equal to the government expenditure on science and technology divided by the general public budget expenditure.

The remaining variables are control variables. pop_t represents population density, which is equal to the total population of the country divided by the land area and then logarithm. $eopen_t$ represents the level of economic openness, equal to the total volume of imports and exports divided by GDP; $fainv_t$ represents the proportion of fixed asset investment in GDP. I used Stata 17.0 software to perform unit root test on the time series of dependent variable y and main explanatory variable x. D(*) is a first-order difference and D2(*) is a second-order difference. The data of the above variables are obtained from the Chinese Statistical Yearbook after calculation and sorting.

3.1. Empirical Analysis

In order to avoid "pseudo regression", it is necessary to use ADF (Augmented Dickey—Fuller) test to test the stationarity of each variable.

Table 2. ADF test results

Variable	ADF value	MacKinnon5% threshold	Conclusion
Y	1.991	-3.000	Non stationary
D(Y)	-2.199	-3.000	Non stationary
D2(Y)	-10.894	-3.000	Stationary
X	-0.415	-3.000	Non stationary
D(X)	-2.758	-3.000	Non stationary
D2(X)	-3.323	-3.000	Stationary

As can be seen from the above table, both y and x sequences are second-order integral. Further Johansen co-integration test shows that there is a co-integration relationship between x and y, which can be used for regression analysis of the model.

3.2. Regression Interpretation

The preliminary results obtained by regression analysis are as follows:

$$y_t = -389351.4 - 0.512x_t + 495058.6lnpop_t - 1525lneopen_t - 20598.7lnfainv_t + \varepsilon_t$$

$$R^2 = 0.9312$$

Firstly, R^2 is approximately 1, indicating that the model has a good fitting degree. However, the coefficient before the main explanatory variable is less than 0, which is inconsistent with the original hypothesis. There are also multicollinearity problems between other variables. The results of the multicollinearity test are as follows.

Table 3. Multicollinearity test

	y	*x*	*pop*	*eopen*	*fainv*
y	1.0000				
x	0.9315	1.0000			
pop	0.8873	0.9660	1.0000		
eopen	-0.6274	-0.7666	-0.8834	1.0000	
fainv	-0.9075	-0.8724	-0.7506	0.3833	1.0000

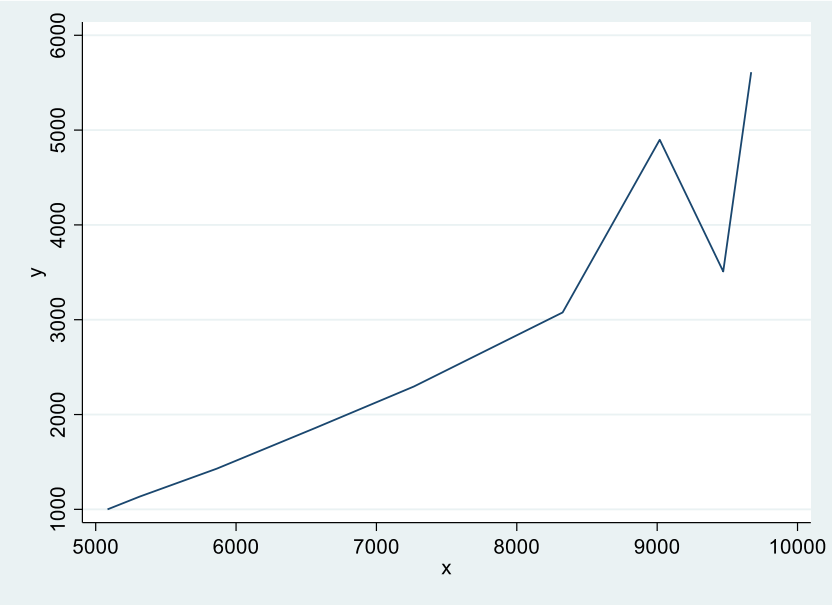

Figure 1. The graph shows the linear relationship between variables y and x

According to the multicollinearity test, the explanatory variables are highly correlated. And we can draw a conclusion that variable y and variable x only conform to the linear correlation in a certain interval value, beyond the interval value, the relationship between the two is worth further discussion. If we do the regression for y and x separately, we get an equation that looks like this:

$$y = -3602.113 + 0.8597x + \varepsilon$$

Meanwhile, the significance level of the equation is less than 5%. Adj R-squared is 84.87%. Coefficient before variable x > 0, indicating that fiscal expenditure on science and technology has a positive effect on the development level of digital economy. This result can prove the hypothesis in this paper.

4. Discussion

Because the measurement of digital economy started late in China and my academic level is limited, the data of digital Economy Development Index can only date back to 2013, and there are only 9 observed values so far. The sample size is too small, so it inevitably leads to the multicollinearity of the estimation model. The hypothesis proposed above cannot be proved completely. From the analysis of appeals, we can see that the theoretical analysis of this paper is correct. To a certain extent, the financial investment in science and technology can promote the high-quality development of digital economy (the development of digital economy is represented by the rise of level index).

After further review of literature, I found that there is not a simple linear relationship between fiscal investment in science and technology and the development of digital economy. Government spending on science and technology promotes innovation. The externality of scientific and technological innovation makes its activity quality lower than the market equilibrium level. This market failure requires the "visible hand" of the government to intervene and guide scientific and technological innovation. As an important force driving

scientific and technological innovation activities, the government can provide momentum for scientific and technological innovation through industrial policies and fiscal spending on science and technology (Lee, 2011). Fiscal spending on science and technology is more targeted and may be more effective than other approaches (Guo, 2016).

Technological innovation has a dual effect on the development of digital economy (Luo, 2019). Limited financial investment in science and technology, the more investment in non-digital technology innovation, will affect the speed of development of digital economy; Otherwise, it will speed up the development of digital economy. It can be seen that the fiscal expenditure on science and technology has both crowding out effect and promoting effect. Therefore, there may be a positive "U-shaped" nonlinear relationship between the fiscal expenditure on science and technology and the development level of digital economy. Relatively speaking, financial investment in science and technology really promote the improvement and construction of digital infrastructure, and then promote the high-quality development of digital economy through the development of digital infrastructure.

5. Conclusions

To sum up, the innovative development of the digital economy needs to be promoted by fiscal policies. The concrete manifestation of the high-quality development of digital economy is the double wheel drive of digital industrialization and industry digitization. Financial investment in science and technology innovation should be more targeted and should not be blindly invested. Later research should focus on the inflection point of the relationship between the fiscal expenditure on science and technology innovation and the development of digital economy, and invest funds within a specific range to maximize the efficiency of capital utilization.

Countries and regions should also formulate fiscal spending policies in line with local conditions of digital economy development. While guiding innovation and promoting innovation in digital technology and infrastructure, the government should not forget to nurture and support digital talents.

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Measurement and Evaluation of Digital Economy Efficiency in RCEP Member Countries

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Abstract: The FTA represented by RCEP is the frontier highland for RCEP member countries to implement the strategy of free trade test area enhancement. The rapid development of digital economy has brought new opportunities for RCEP to deepen investment and trade and promote regional synergistic development. Based on the digital economy input-output data of RCEP countries from 2011 to 2020, this paper quantitatively analyzes and evaluates the digital economy efficiency of RCEP countries using three-stage DEA model and Malmquist index. The results show that: the digital economy efficiency of RCEP countries is low and there is a "digital divide"; scale efficiency is the main factor affecting the low digital economy efficiency; external environmental variables and random errors have some influence on the digital economy efficiency, and the digital economy efficiency of RCEP countries decreases after excluding the external influence. China has obvious advantages in digital economy efficiency and has spillover effects on neighboring countries and China's trade partners.

Keywords: digital economy efficiency; RCEP; three-stage DEA

JEL Classification: R12; O11; O33

1. Introduction

The world economic recovery is sluggish due to the combination of the epidemic of the century and the century-old changes. The reconstruction of international economic and trade rules accelerated. Free trade zones have become an important "stage" for driving global economic change. On January 1, 2022, the Regional Comprehensive Economic Partnership Agreement (RCEP) entered into force. As the world's largest FTA, RCEP covers 29.98% of the world's population, 29.76% of its GDP and 29.51% of its goods import and export trade. RCEP is comprehensive, modern, high quality and mutually beneficial. The entry into force of RCEP has become a bridge and a link between China's domestic and international cycles. It also makes digital trade the focus of competition in the new round of international trade rules. This has far-reaching significance for realizing the high-quality development of China's digital economy and the construction of digital economy in RCEP region.

The digital economy is driving a global technological revolution in the post-epidemic era, becoming a new competitive advantage in international cooperation and changing the landscape of international trade (Han et al., 2019). The impact of "data" on a country's politics, economy and culture is growing (Shen et al., 2022). However, in recent years, most countries

around the world have not shown the expected increase in economic development brought about by the digital economy, and the efficiency of the digital economy has become a concern. There is a growing debate about whether a "new Solow paradox" has emerged: the digital economy is everywhere but not captured in macroeconomic statistics (Xu & Zhang, 2020). This means that in the new global supply chain dominated by digital business rules, the existing statistical methods of digital economy utilization efficiency cannot fully cover the problems caused by the digital economy. The issue of digital economy efficiency in each country is becoming a compelling focus, and the measurement of digital utilization efficiency needs to be urgently addressed. In this context, it is important to investigate the digital economy efficiency of RCEP member countries in order to judge the economic situation of RCEP FTA and regulate the development of digital industry in FTA. It is also important for the high-quality development of digital economy in China.

2. Literature Review

The research closely related to this paper mainly focuses on the measurement of digital economy scale and the measurement of digital economy efficiency. In the research on the measurement of the scale of the digital economy, scholars from various countries have different research perspectives. Chinese scholars focus on practical application based on theoretical measurement, while scholars from other countries focus on the measurement methods of the digital economy and theoretical research on the compilation of relevant indexes. The research of scholars from various countries mainly carries out from the following three perspectives, one is the research on the national accounting method of the scale of the digital economy and the compilation of related indexes, Barefoot et al. (2019) discussed methods such as data capitalization in the United States and the data value of the digital economy, Ahmad and Ribarsky (2020) the problems existing in the data accounting process of the traditional national accounting system are analyzed, and relevant suggestions are put forward for the data accounting scheme; In terms of measuring the added value of the digital economy, the US Bureau of Economic Analysis BEA used the supply and use table to explain the scope of the US digital economy and measure the added value of the US digital economy. In addition, in terms of index compilation, the United Nations International Telecommunication Union (ITU) has published the ICT Development Index (IDI) and multiple editions of the "Measuring the Information Society Report" since 2009, the European Commission has released the "Digital Economy and Society Index", and the US Bureau of Economic Analysis (BEA) measures the development level of digital economy in multiple dimensions. Qu et al. (2022) constructed a carbon emission measurement framework for China's digital economy; Xu and Zhang (2020) constructed an accounting framework for the scale of the digital economy, and systematically tested the development scale and structure of China's digital economy. Guan et al. (2020) proposed a statistical classification of China's digital economy industry, including specific categories such as digital equipment manufacturing and digital information transmission, and compared and analyzed it with existing international indicators. Cai and Niu (2021) measured the indicative comparative advantage index and technology content level of China's ICT manufacturing and ICT service

industries based on export value-added accounting. Wang et al. (2021) conducted research on the digital economy development index of China's provinces and regions through the entropy value method, and Mu and Ma (2021) took rural agriculture as the starting perspective. To measure the digital economy development index of China's eight major regions, some scholars from the urban agglomeration (Zhang & Li, 2022), the Yellow River Basin (Li, 2022), and the international perspective (Qi & Ren, 2020) to start a discussion.

Scholars' calculation of the digital economy mainly starts from two aspects, and the calculation method still mainly adopts data envelopment analysis. The first is to explore the efficiency of digital economy development at the regional level, such as measuring the whole of China (Qi, 2022) and the Yangtze River Economic Belt (Liu et al., 2022), and the second is to use the digital economy International comparison, Zhao and Wang (2022) on the comparative analysis of the digital economy efficiency of China and the United States, Liu et al. (2021) with the "Belt and Road" The perspective is the starting point to analyze the digital economy efficiency of countries along the Belt and Road. In addition, there are other methods used to measure the efficiency of the digital economy, mainly including the undesired output method considering the transpose and distance functions, and the super efficiency method considering the relaxation variable, such as Ahmad and Schreyer (2016) and McKinsey (2017).

There have been many studies on the theoretical connotation and development measurement of digital economy in the past. However, few studies have been conducted on the measurement of the regional and international digital economy development level of emerging FTAs, mainly focusing on the digital economy efficiency of some domestic and international regions in China. Moreover, the measurement of digital economy efficiency is mostly based on a single DEA analysis, which fails to solve the radial and perspective problems in traditional models. Therefore, this paper includes environmental factors into the scope and is based on a three-stage DEA measurement method to measure the digital economy efficiency of RCEP countries in a more scientific way. This is to provide a reference for the construction of RCEP FTA and the development of digital economy in RCEP countries.

3. Research Method and Index System Construction

3.1 Three-stage DEA Model

The traditional DEA analysis method has been widely used to evaluate efficiency indicators because it can handle multiple inputs and outputs and does not require the construction of a production function for parameter estimation, but Fried et al. (2002) argue that environmental factors, stochastic disturbances and management inefficiency affect the traditional DEA efficiency analysis, resulting in biased results. The model is more accurate in measuring the efficiency of digital economy (Ting et al., 2022). The specific idea of the model is as follows.

DEA-BCC model. In the first stage, this paper uses the traditional DEA-BCC model to evaluate the efficiency of digital economy in 15 countries of RCEP. The model is:

$$\begin{gathered}\min[\sigma-\varepsilon(e_1^T s_i^- + e_2^T s_r^+)] \\ s.t.\sum_{j=1}^{n}\lambda_j x_j + s_i^- = \sigma x_0 \\ \sum_{j=1}^{n}\lambda_j y_j - s_r^+ = y_0 \\ \sum_{j=1}^{n}\lambda_f = 1, \lambda^f \geq 0, j = 1,2,\cdots n \\ s_r^+ \geq 0, s_i^- \geq 0,\end{gathered} \tag{1}$$

where θ is the efficiency value of RCEP countries, and for input and output relaxation variables, $s_i^- s_r^+ \varepsilon$ is non-Archimedean infinitesimals, and identity vector spaces, and input, output, and weights for country j. $e_1^T e_2^T x_j y_j \lambda_j$ If $\theta = 1$, and, $s_i^- = s_r^+ = 0$DMU is valid for DEA; If $\theta = 1$, $s_i^- = 0$ or $s_r^+ = 0$, then DMU is valid for weak DEA. If so, DMU$\theta < 1$ is valid for non-DEA.

SFA regression model. The SFA regression model was used to eliminate the influence of external environmental factors, random interference and management inefficiency. The constructed SFA regression model is $s_{ij} = f(Z_j; B_j) + v_{ij} + \mu_{ij}$ where is the s_{ij} relaxation value; is the Z_j environmental variable, B_j is the effect Z_j of the pair s_{ij}, is $v_{ij} + \mu_{ij}$ the mixing error; $\mu \sim N(0, \sigma_\mu^2)$ for management inefficiency, that is, the impact of management factors on input relaxation variables. Therefore, management inefficiency is estimated to be $E(\mu_i|\varepsilon_i) = \frac{\lambda\sigma}{1+\lambda^2}[\frac{\varphi(\varepsilon_i)}{\phi}]$. Further estimate of the random error condition: $E(v_i|\varepsilon_i) = s_{ij} - f(Z_j; B_j) - E(\mu_i|\varepsilon_i)$. Based on the DEA effective RCEP countries, the input variables of RCEP countries during the study period were adjusted as follows $x_{ij}^* = x_{ij} + [\max\{f(Z_j; B_j)\} - f(Z_j; B_j)] + [\max\{v_{ij}\} - v_{ij}]$. Among them, it is the x_{ij}^* adjusted input, which is the $[\max\{f(Z_j; B_j)\} - f(Z_j; B_j)]$ adjustment of the external environment, and $[\max\{v_{ij}\} - v_{ij}]$ it is to put all DMUs at the same level.

Adjusted DEA model. After adjusting for the second stage of SFA, the DEA-BCC model is used again to measure the digital economy efficiency of RCEP countries, and the final efficiency value obtained.

3.2 Indicator Selection and Data Sources

By combing the existing literature and research results on digital economy efficiency, this paper takes 15 RCEP countries from 2011 to 2020 as research samples, and draws on the research results of Liu et al. (2021) based on the three dimensions of digital economy efficiency: input, output and environment, to construct RCEP National digital economy efficiency measurement index system (see Table 1). The data were obtained from the World Bank database, where missing data were interpolated using proximate elements and mean values.

Table 1. Indicator system

Dimension	Index	Specific indicators	Unit
Input indicators	Talent investment	Spending on education	percentage
	Digital infrastructure	Number of Internet links	piece
	Market activity	The volume of broad money as a percentage of GDP	percentage
Output indicators	Expected output	ICT industry merchandise exports	USD
		High-tech exports as a percentage of manufactured goods	percentage
	Undesired output	CO2 emissions per capita	kg/m³
Environment variable	Business environment	Level of urbanization	Person
	Innovation environment	Number of scientific papers	Piece

Human capital investment and physical capital investment are the main input indicators of digital economy efficiency. Given the availability of data and the positive correlation between the intensity of education investment and the improvement of talent quality (Wang & Wu, 2022) this paper selects the intensity of education investment as the human capital investment indicator for each country. In terms of physical capital investment, this paper selects the number of Internet links and the share of broad money volume in GDP for characterization. First, because digital infrastructure construction is the foundation of digital economy development in RCEP countries; second, the increase of market activity helps to stimulate the development of digital economy.

The output of digital economy efficiency is mainly measured by desired and undesired outputs. The ICT industry plays an important role in driving the development of the global digital economy. In terms of undesired outputs, traditional industries contribute to carbon emissions in the production process, while the digital economy can reduce urban carbon emissions and increase total factor carbon productivity in cities, which will enable a low-carbon urban productivity (Zhang et al., 2022).

In the dimension of environmental variables, the business environment can directly reflect the operation of a country's market economy, cultivate the survival and development of market players, and its optimization will help shape new advantages in the digital economy. The innovation environment helps to improve the efficiency of the digital economy in all countries, which in turn is a new engine for innovation and development.

4. Empirical analysis

4.1 Empirical Analysis of the Phase I DEA-BCC Model

In the first stage, the DEA-BCC model is applied to measure the digital economy efficiency of RCEP countries from 2011 to 2020. The results show that the overall efficiency, pure technical efficiency and scale efficiency of the digital economy of the 15 RCEP member countries are 0.778, 0.885 and 0.864, respectively. the scale efficiency and pure technical efficiency values are high, but the scale efficiency may be the main factor that causes the digital economy efficiency of RCEP member countries not to reach the DEA validity in comparison. The changes in efficiency during the sample period are analyzed in conjunction

with Figure 1. During the examination period, digital economy efficiency shows a fluctuating upward trend, rising from 0.765 in 2011 to 0.785 in 2020, with the highest value point in 2015, which reflects the improvement of the adequacy of digital economy development utilization in RCEP countries. However, the above analysis does not exclude the effects of environmental variables and random perturbations, and cannot reflect the true digital economy efficiency of RCEP member countries. The following section will explain how environmental variables and stochastic factors affect the efficiency results through the second stage of SFA regression.

4.2 Analysis of SFA Regression Results in the Second Stage

To explain the degree of influence of environmental factors, stochastic factors and managerial inefficiency on the efficiency of inputs in the digital economy, SFA regression analysis was conducted using frontier4.1. The results of the second stage SFA regression for the most recent year of the study period, 2020, were selected and are shown in Table 3. The one-sided generalized likelihood ratio test of the regression results is significant at the 1% level, rejecting the original hypothesis that there is no inefficiency term, i.e., the SFA model is reasonably set up (Table 2). The regression results for each input slack variable with aγ values are all 1, which are significant at the 1% level, indicating that management factors dominate in the efficiency values and each external environmental variable has a significant impact on the efficiency of the digital economy. Specifically, as shown in Table 2.

Table 2. SFA results

variable	Slack variables					
	Education expenditure inputs Slack variables	T value	Number of internet connections Put in the relaxation variable	T value	Broad monetary volume put in the relaxation variable	T value
Constant terms	-59,934.489***	-59,934.034	-2.038	-0.946	-23,709.74***	-6,019.58
Level of urbanization	1,206.732***	-1,180.870	0.618***	18.158	347.62*	1.10
Number of scientific papers	1.990*	1.368	0.0001***	10.461	-0.020	-0.05
σ^2	31,387,960,000.0	31,387,960,000.0	2,001.391	1,995.438	165,088,990.0	165,088,990.0
γ	1.000	23,406.256	1.000	620,384.770	1.00	2.54
LR test of the one-sided error	6.923		4.712		6.493	

The first is the level of urbanization. The calculation results show that the regression coefficient of urbanization level is significantly negative with the slack variable of education expenditure and significantly positive with the slack variables of the number of Internet connections and the share of broad money. This implies that an increase in urbanization level can effectively reduce the redundancy of education expenditures and help improve the efficiency of the country's digital economy. Next is the number of scientific and technical

papers. The calculated results show that the regression coefficients of the number of scientific and technical papers and the three input slack variables are positive. This means that the higher the number of scientific and technical publications is not conducive to the improvement of digital economy efficiency in RCEP countries, and it is a "burden" to the improvement of digital economy efficiency. Although the publication of scientific and technical papers can reflect the level of science and technology in each country to a certain extent, science and technology will lead to uneven progress in different regions. This phenomenon is particularly evident in countries with uneven economic development, which leads to a less efficient digital economy.

4.3 Empirical Snalysis of the Third Stage DEA-BCC Model

According to the results of the second-stage SFA regression excluding the influence of environmental and random factors, adjusting each input variable and re-calculating the efficiency values of the model, the specific results are shown in Table 3. the mean values of the real digital economy efficiency, pure technical efficiency, and scale efficiency of RCEP countries from 2011 to 2020 are 0.688, 0.983, and 0.699, respectively, which are lower than the efficiency values of the first stage. This indicates that the third stage efficiency value effectively corrects the overestimation of the first stage efficiency value, and from 2014 to 2016, the digital economy technical efficiency of RCEP countries increased from 0.677 to 0.823 and then to 0.694, and the main reason for the obvious increase in efficiency is the increase in scale efficiency. The possible reason is that the World Bank used the concept of "digital dividend" in the World Development Report in 2016, and the role of the digital economy in driving innovation has become a new hot spot in the global economy. highlighted, with developing countries accounting for more than 2/3 of the RCEP countries, while the volume and scale of the digital economy in developing countries are somewhat different from those in developed countries, and the conversion efficiency of resource utilization is poor. This is followed by a higher value to 2020, which is similar to the trend of pure technical efficiency. Throughout the study period, the change trend of digital economy technical efficiency of RCEP countries is similar to the change trend of scale efficiency.

In terms of the efficiency values for each country, the ones that are always DEA efficient in the digital economy during the study period are Brunei and Singapore. China, Korea, Australia, Philippines, and Malaysia have DEA effective status during the study period. Among them, Korea and Malaysia's DEA efficiency values remain above 0.95, showing a stable and good trend. Australia and the Philippines had small fluctuations in efficiency values from 2011-2015, followed by a stable DEA validity. Fluctuations in scale efficiency make China's efficiency values more volatile in 2015-2020. New Zealand, Laos and Vietnam have fluctuating and increasing efficiency values, while Japan shows a stable development and maintains an average level of around 0.6. The efficiency values of Myanmar, Cambodia and Indonesia never exceed 0.3, with Myanmar having the lowest digital economy efficiency value. Most of the countries' digital economy efficiency values fluctuated significantly from 2014-2016, due to the changes in the global digital economy in that year, with a slow development trend of fluctuations slowing down after 2017.

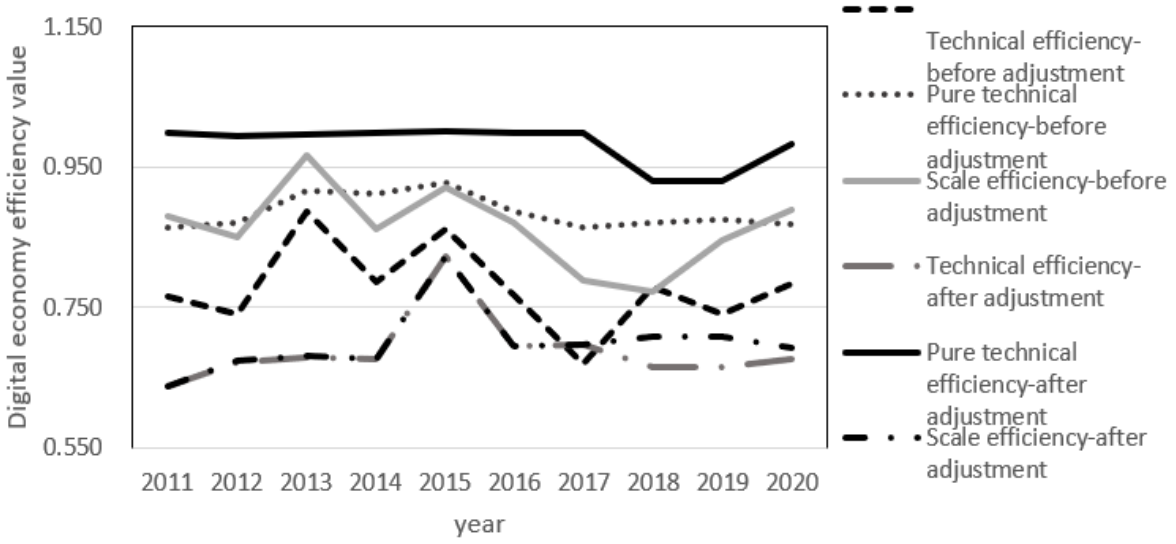

Figure 1. Comparison of digital economy efficiency in RCEP countries in the first and third phases

And according to the study, the level of pure technical efficiency of digital economy in RCEP countries in the third stage has improved compared to the first stage, and the number of countries with efficiency values less than 1 has decreased year by year. The presence of insufficient output or redundant funding is significantly improved after the exclusion of environmental variables and random effects. The study also shows that the lower efficiency values of the digital economy due to scale efficiency are more widespread, as increasing or decreasing returns to scale make the scale efficiency values deviate from the effective value of 1. Low scale efficiency is the main reason for the low efficiency values of the digital economy in RCEP countries.

Table 3. Results of the third stage measurement of digital economy efficiency in RCEP countries

Country	In 2011			In 2014			In 2017			In 2020		
	TE	PTE	SE	TE	PTE	SE	TE	PTE	SE	TE	PTE	SE
China	1.000	1.000	1.000	0.918	1.000	0.918	0.817	0.97	0.843	0.727	0.811	0.896
Japan	0.682	1.000	0.682	0.701	0.998	0.702	0.628	0.999	0.628	0.665	0.956	0.696
Korea	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Australia	0.939	1.000	0.939	1.000	1.000	1.000	0.931	1.000	0.932	1.000	1.000	1.000
New Zealand	0.402	0.999	0.403	0.466	0.999	0.467	0.409	0.999	0.41	0.506	0.985	0.514
Indonesia	0.297	0.997	0.298	0.217	1.000	0.218	0.279	1.000	0.279	0.256	1.000	0.256
Malaysia	1.000	1.000	1.000	1.000	1.000	1.000	0.952	1.000	0.952	1.000	1.000	1.000
Philippines	0.929	1.000	0.929	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Thailand	0.529	0.999	0.53	0.546	0.999	0.547	0.494	1.000	0.494	0.49	0.981	0.499
Singapore	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Brunei	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Cambodia	0.028	1.000	0.028	0.037	1.000	0.037	0.08	1.000	0.08	0.078	0.996	0.078
Laos	0.234	1.000	0.234	0.517	1.000	0.517	0.757	1.000	0.757	0.46	1.000	0.46
Myanmar	0.013	1.000	0.013	0.026	1.000	0.026	0.143	1.000	0.143	0.077	1.000	0.077
Vietnam	0.500	1.000	0.5	0.729	1.000	0.729	0.95	1.000	0.95	0.896	0.998	0.898
mean	0.637	1.000	0.637	0.677	1.000	0.677	0.696	0.998	0.698	0.677	0.982	0.692

To further analyze the dynamic evolutionary characteristics of the efficiency of the digital economy in RCEP countries, Figure 2 shows the results of the estimated Kernel density of the third stage of the digital economy in RCEP countries from 2011 to 2020. It is found that the center of the Kernel density distribution curve of the digital economy of RCEP countries gradually fluctuates to the right from 2011 to 2020, which indicates that the level of digital economy development of RCEP countries is fluctuating and slowly growing during the period under examination. The main peak wave from 2011 to 2020 shows a rising trend and then decreasing trend, and the width gradually narrows, which indicates that the efficiency of digital economy development of RCEP countries the fluctuating and uneven nature of the wave shows a significant increase. It is further observed that, unlike the first stage, the curve shows a multi-peak distribution phenomenon, but the side peaks have smaller peaks and larger widths. This further indicates that the development of digital economy in RCEP countries always shows multipolar phenomenon and has certain gradient characteristics.

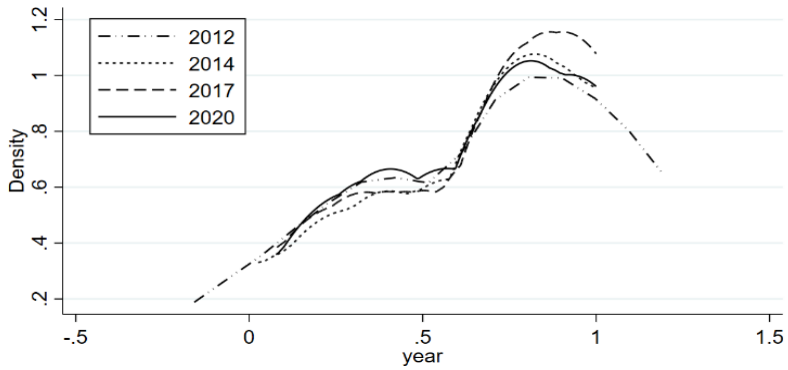

Figure 2. Kernel density estimation results of the third stage

To further delve into the efficiency of the digital economy in RCEP countries, the input variables and raw outputs excluding external environment and stochastic factors are brought into the Malmquist Productivity Index model for measurement. In order to supplement the above results from a dynamic perspective. The specific measurement results are shown in Table 4. Overall, the digital economy efficiency values of RCEP countries fluctuate and level off during the study period, developing at a high rate between 2012 and 2015, reaching an increase of 54.38% between 2014 and 2015. It then shows a more stable development, but shows a small decrease between 2019 and 2020. From the decomposition of efficiency changes in the digital economy, the comprehensive efficiency changes continue to develop between 2011 and 2014, and then show a trend of "decline - rise - decline", and reach a higher value between 2019 and 2020, with a clear sign of improvement compared with the previous measurement period. For pure technical efficiency changes, it basically remains at the measurement level of 1.000 and increases significantly during 2018-2020; the changes in scale efficiency are similar to the changes in the overall efficiency of digital economy. Overall, the change in scale efficiency is the main factor leading to the change in the value of integrated efficiency of the digital economy. This is consistent with the findings of the static analysis.

Table 4. Malmquist efficiency value of digital economy in RCEP countries and its decomposition

year	effch	techch	pech	sech	tfpch
2011-2012	1.169	0.495	0.995	1.174	0.578
2012-2013	0.961	0.980	1.002	0.959	0.942
2013-2014	1.028	5.899	1.003	1.025	6.066
2014-2015	1.586	0.111	1.000	1.585	0.176
2015-2016	0.759	0.485	1.000	0.759	0.368
2016-2017	0.998	1.402	0.998	1.000	1.399
2017-2018	0.893	5.361	0.913	0.977	4.785
2018-2019	1.000	0.053	1.013	0.987	0.053
2019-2020	0.929	2.002	1.059	0.877	1.861
mean	1.016	0.792	0.998	1.018	0.804

4. Discussion

Based on the digital economy-related input data, output data and environmental variable data of RCEP countries from 2011 to 2020, this paper uses a three-stage DEA model to calculate and analyze the digital economy efficiency, and finally obtains the following conclusions:

1. The digital economy efficiency of each RCEP country is influenced by environmental factors. The level of urbanization has a significant positive impact on education expenditure, which can effectively reduce the redundancy of education expenditure. The horsepower effect makes the local technology level increase the input redundancy, thus making it a "burden" to the digital economy efficiency.
2. Scale efficiency is the main reason for the low efficiency of the digital economy in RCEP countries. Compared with the results of the first stage, the results of the third stage show that the overall technical efficiency value of RCEP countries is fluctuating upward, the average value of overall technical efficiency is decreasing, the average value of scale efficiency is also decreasing, and the average value of pure technical efficiency is increasing. It shows that the low efficiency of digital economy in RCEP countries is mainly caused by low scale efficiency rather than pure technical efficiency.
3. The "digital divide" among RCEP countries persists. The digital economy efficiency values of Brunei and Singapore are always DEA effective, while those of Korea, China, Australia, Malaysia and the Philippines are always above 0.9, and the lowest digital economy efficiency values are in Cambodia and Indonesia. China's booming digital economy has spillover effects on RCEP partner countries and is particularly beneficial to neighboring countries and China's trading partners.

However, some scholars still investigate this issue from other perspectives, for example, Jiang et al. (2022) also explores the efficiency of the core and support industries of China's digital economy from the perspective of input-output tables and investigates their impact mechanisms. The study finds that macroeconomic variables are not the key to enhancing the efficiency of the core industries of the digital economy. The focus of enhancing the efficiency of digital economy industries is to emphasize the wide application of information technology

tools in manufacturing and the deep penetration in the real economy in the areas of production, exchange, circulation and distribution. Wang (2022) explores RCEP as an example to conclude that the level of digital economy development of trade subjects has a positive contribution to bilateral trade and trade efficiency, and Liang and Jiao (2022) systematically analyze the current situation and trend of digital economy development in RCEP member countries and construct a digital economy enhancement path from digital trade rules, digital trade facilities and global value chain, which also side by side supports the This paper also supports the necessity of measuring the efficiency of digital economy of RCEP member countries, and lays the foundation for enhancing the development of digital economy in RCEP region and subsequently exploring the path of digital economy enhancement of RCEP member countries. It is important to study the digital economy issues of RCEP countries and how to make the digital economy work for economic development and digital trade cooperation, which is our future research direction to explore in this area.

5. Conclusion

The obtained research results can help improve the efficiency of digital economy in RCEP member countries, and the following recommendations are related to our research: firstly, we should accelerate the construction of digital economy infrastructure and promote the digital economy cooperation among RCEP member countries. The new infrastructure represented by digital infrastructure can effectively break the boundaries of information, knowledge and industry, and provide the preliminary foundation for the deep application of digitalization in the future. The gap between countries will be the gap in innovation capacity supported by technological revolution, the gap in digitalization process, and the gap in digital finance and digital economy supported by digital technology. Countries should seek common ground, promote economic cooperation, and work together to bring sustainable solutions to the multiple complexities of the Internet and explore the opportunities it presents.

Conflict of interest: none

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The Impact of Digital Economy on Technological Innovation of Manufacturing Enterprises from the Perspective of Virtual Agglomeration: Evidence from China

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Abstract: As China enters the era of digital economy, it is of great significance to study the influence of digital economy on technological innovation of manufacturing enterprises. This paper measures the level of digital economy and virtual agglomeration of industry in about 30 provinces (municipalities and autonomous regions) in China except for Tibet and makes an empirical study with the data of listed manufacturing companies from 2012 to 2020. The results show that digital economy can improve the output and efficiency of technological innovation of manufacturing enterprises, but this promoting effect is only significant in the eastern and central regions, non-large manufacturing enterprises, and non-state-owned enterprises. The testing results of the mechanism show that the digital economy merely promotes the technological innovation output of manufacturing enterprises by accelerating the virtual agglomeration of industrial specialization and diversification, but does not improve the efficiency of technological innovation of manufacturing enterprises. In the future, China should accelerate the development of the digital economy. Manufacturing enterprises should accelerate the pace of digital transformation. And the government and manufacturing enterprises should jointly accelerate the construction of industrial Internet platforms for enhancing the spillover effect of technological innovation resources.

Keywords: digital economy; virtual agglomeration; technological innovation of manufacturing enterprises

JEL Classification: L60; O14; O32

1. Introduction

80% of China's technological innovation is generated by manufacturing enterprises. Therefore, accelerating the technological innovation of manufacturing enterprises is an important way to enhance the scientific and technological strength of the nation. In 2021, the added value of China's manufacturing industry reached 31.4 trillion yuan, ranking first in the world for 12 consecutive years, but manufacturing enterprises are still facing problems such as weak technological innovation and "stuck neck" technology being controlled by others, so it is urgent to find new momentum for technological innovation of manufacturing enterprises. The development of the digital economy not only accelerates the digital

transformation of technological innovation which includes methods, models, management, processes, and results, but also enables manufacturing enterprises to achieve cross-regional and cross-organizational communication, reduces the cost of information search and acquisition, enhances the spillover effect of knowledge and technology, and enhances the allocating efficiency of technological innovation resources. This new pattern of shifting manufacturing enterprises from geographical agglomeration to network agglomeration is called a new organizational form of virtual agglomeration, including specialized and diversified virtual agglomeration. Compared with the form of geographic agglomeration, virtual agglomeration not only changes the resource allocation mode and efficiency of economic activities by accelerating knowledge spill, but also avoids the problems of land scarcity, traffic congestion, and environmental pollution caused by geographical agglomeration, and reduces the congestion effect of agglomeration.

So, will the digital economy promote technological innovation of manufacturing enterprises, and is there heterogeneity in this promotion? Does the digital economy promote technological innovation of manufacturing enterprises through virtual agglomeration? Clarifying the above issues is of great significance to enhance the technological innovation capabilities of manufacturing enterprises in the context of the digital economy.

Therefore, this paper integrates the digital economy, virtual agglomeration, and technological innovation of manufacturing enterprises into the same framework, and uses the listed company data of manufacturing enterprises and provincial panel data in China from 2012 to 2020 to carry out research. Based on measuring the level of specialized and diversified virtual agglomeration, the two-way fixed model is used to test the impact effect of digital economy on the technological innovation of manufacturing enterprises, and the heterogeneity analysis of manufacturing enterprise samples of different industries, regions, enterprise sizes and equity types is carried out. Then, the mediation effect model is used to test the influence mechanism of specialized and diversified virtual agglomeration.

2. Literature Review

2.1. The Impact of the Digital Economy on the Technological Innovation of Manufacturing Enterprises

Some scholars studied the impact of the digital economy on the technological innovation of manufacturing enterprises. The digital economy brought new digital technologies to manufacturing enterprises, accelerated the flowing and sharing of knowledge and technological resources, and contributed to technological innovation among manufacturing enterprises (Tommaso et al., 2021; Christian et al.,2022). The digital economy created a favorable institutional environment for the technological innovation of manufacturing enterprises, realized the transparency of market information, and expanded the main body of enterprise technological innovation into a diversified innovation organization composed of the government, enterprises, universities, and users. In addition, there was heterogeneity in the role of the digital economy in promoting technological innovation of manufacturing enterprises, and the role of digital economy in promoting technological innovation of

knowledge- and technology-intensive manufacturing enterprises were more significant (Zheng et al., 2022). The above literature analyzed the impact of the digital economy on the technological innovation of manufacturing enterprises from the perspective of the external environment and internal technological innovation subjects of enterprises, however, the analysis of other factors affecting the technological innovation of manufacturing enterprises needs to be supplemented.

2.2. Virtual Agglomeration

At present, the literature on virtual agglomeration mainly includes three categories. The first is to define the connotation of virtual agglomeration. Considering virtual agglomeration is a new organizational form, in which multiple enterprises in or between industries gather on the network platform for information interchange and cooperation, and there were no time and space constraints on the platform (Brown & Lockett, 2001). The second is to summarize the advantages of virtual agglomeration. The network platform supporting virtual agglomeration was operated in a community-based mode, shortening the psychological distance between enterprises through formal and informal systems in digitally networked communities, and promoting enterprise exchanges (Muzzi & Albertini, 2015). The third is to measure the level of virtual agglomeration. By using the method of sharing movement, Zhao et al. (2022) calculated the penetration of digital services as a measurement indicator of the virtual agglomeration level of manufacturing, which the data required for the calculation include the input-output data of OECD and the first census of industrial enterprises in China. The existing literature only measured the level of virtual agglomeration of manufacturing specialization. In fact, in addition to specialized virtual agglomeration, the diversified virtual agglomeration of manufacturing enterprises and productive service industries will also have an important impact on technological innovation.

2.3. The Impact of the Digital economy on the Technological Innovation of Manufacturing Enterprises through Virtual Agglomeration

A small number of scholars conducted their studies by combining digital economy, virtual agglomeration, and technological innovation of manufacturing enterprises. The development of a new generation of information technology provided support for a technical platform for the virtual agglomeration of manufacturing enterprises and accelerated the aggregation of decentralized capabilities of innovation. Manufacturing enterprises accelerated the transfer of knowledge through acquisition, absorption, and integration of technological innovation resources, to improve the level of technological innovation (Alsharo et Al., 2017; Zhang and Ren, 2018; Feng, 2018). Chen et al. (2022) constructed an analysis framework including intelligent services, factor agglomeration, and regional innovation, and concludes that intelligent services can improve regional innovation performance by enhancing the spillover effect of virtual agglomeration elements. However, how the digital economy affects the technological innovation of manufacturing enterprises through virtual agglomeration needs further research.

3. Methodology

3.1. Theoretic Mechanism

The impact of the digital economy on the technological innovation of manufacturing enterprises includes three aspects. First, the method of technological innovation is combinatory. The technological innovation methods in the era of digital economy are no longer limited to the joint effect of theoretical foundation, professional technology, and market goals, but the recombination of a new generation of information technology and information to achieve collaborative innovation through multiple technologies; Second, the pattern of technological innovation is shared. The original research and development personnel come from manufacturing enterprises, but the digital economy breaks the restrictions on research and development personnel, promotes cooperative innovation in multiple organizations and fields, and accelerates the construction of innovation ecosystems. Third, the management of technological innovation is a breakthrough. In the era of digital economy, digital knowledge and information become an important factor of production, when it is difficult for enterprises to manage non-standardized and unstructured data, they only need to search, obtain and analyze data on the cloud platform where data is stored according to their demand, which reduces the cost of acquiring and managing technological innovation resources of manufacturing enterprises, thereby promoting technological innovation output and efficiency improvement. Fourth, the technological innovation process is non-linear. In the era of digital economy, manufacturing enterprises break linear thinking and realize the nonlinear transformation of technological innovation in time and space, which enables manufacturing enterprises to carry out the production of the product, research, and development at the same time. Fifth, the results of technological innovation are universal. As a new factor of production in the era of digital economy, compared with traditional factors of production such as labor and land, data can be copied infinitely. Therefore, the technological innovation results generated by the use of data elements can also be reused as new elements, thereby accelerating the generation of new technological innovation results.

Furthermore, the digital economy also promotes technological innovation of manufacturing enterprises through specialized and diversified virtual agglomeration. First, the digital economy reduced the thinking dependence of manufacturing enterprises by accelerating specialized and diversified virtual agglomeration, making communication between enterprises more convenient. Through the integration of specialized and diversified knowledge, the technological innovation process is promoted to open and inclusive, and there are many innovation patterns such as networked research and development and e-innovation community, which in turn promotes the technological innovation output and efficiency improvement of manufacturing enterprises (Andrea et al., 2020; Jun et al.,2020). Second, the digital economy reduced the cost of enterprise information search and matching and saved the cost of technological innovation by aggregating manufacturing enterprises and productive service enterprises on the network platform (Maria et al., 2004). Third, through specialized and diversified virtual agglomeration, the digital economy accelerated the

generation of economies of scale and the competitiveness of manufacturing enterprises, thereby helping enterprises improve the efficiency of technological innovation.

Based on theoretical analysis, the following hypotheses are proposed:

- H1. The digital economy can accelerate the technological innovation output and efficiency improvement of manufacturing enterprises.
- H2. The digital economy can accelerate the technological innovation output and efficiency improvement of manufacturing enterprises through specialization and diversified virtual agglomeration.

3.2. Model Establishment

Firstly, in order to test whether the digital economy can directly accelerate the technological innovation output and efficiency improvement of manufacturing enterprises, this paper constructs a benchmark regression model, as shown in (1):

$$Inn_{it}=\beta_0+\beta_1 De_{jt}+\beta_2 Controls+\theta_t+\mu_n+\varepsilon_{jt} \quad (1)$$

In model (1), the subscript i, j, n, and t represent the enterprise, province, industry, and year, The Inn indicates the level of technological innovation of manufacturing enterprises, including the level of technological innovation output (*Innout*) and the efficiency of technological innovation (*Inneff*). The *De* represents the level of the digital economy, the *Controls* represents the control variables at the enterprise level and regional level, and. To control the impact of year and industry factors on the technological innovation of manufacturing enterprises, θ represents the year-fixed effect, and μ represents the industry-fixed effect.

If the β_1 in the first model is significant, it is further tested whether the digital economy can accelerate the technological innovation output and efficiency improvement of manufacturing enterprises through specialization and diversified virtual agglomeration, specifically referring to the mediation effect test proposed by Wen Zhonglin and Ye Baojuan in 2014. As shown in models (2) and (3).

$$Med_{jt}=\beta_0+\beta_1 De_{jt}+\beta_2 Controls+\theta_t+\mu_n+\varepsilon_{jt} \quad (2)$$

$$Inn_{it}=\beta_0+\beta_1^{'} De_{jt}+\delta Med_{jt}+\beta_3 Controls+\theta_t+\mu_n+\varepsilon_{jt} \quad (3)$$

In models (2) and (3), the *Med* represents the level of virtual agglomeration, the remaining subscripts have the same meaning as model (1).

3.3. Data Source and Variable Selection

The data in this paper are derived from the Statistical Yearbook of China, the Wind database, and the Guotai'an database. This paper takes China's A-share manufacturing listed companies as the research object, matches the provincial digital economy and virtual agglomeration of industry, and finally constructs the panel dataset from 2012 to 2020.

The explained variables in this paper are the technological innovation output and the efficiency of manufacturing enterprises. Referring to the research results of Qing and Huang

(2021), the number of patent applications is used to measure the technological innovation output of enterprises. At the same time, during data processing, it is found that the number of patent applications of manufacturing enterprises in individual years is 0, so adding 1 to the number of patent applications and then taking the logarithm. ensuring the validity of the sample on the one hand, and reducing the standard error of the variable on the other hand. Drawing on Chang's (2020) measuring method of technological innovation efficiency, this paper uses an SBM model containing undesired output to calculate the technological innovation efficiency of manufacturing enterprises. The input elements in the model include capital and human capital, which are respectively measured by research and development funding and the number of personnel. The expected output is the number of enterprise patents, measured by the number of invention patents authorized by the manufacturing enterprise in the current year. Non-expected output refers to the innovation loss that occurs in the process of innovation output of manufacturing enterprises, measured by the average number of invention patent applications in the past three years minus the number of invention patents granted in the current year. The reason for choosing the average number of invention patent applications in the past three years is that the period from application to grant of invention patents is generally 1-3 years. In the robustness test, the ratio of the log of the patent application to the amount of research and development investment is used to measure the technological innovation efficiency of manufacturing enterprises (Chen et al., 2021).

The core explanatory variable in this paper is the level of the digital economy. An important prerequisite for the development of the digital economy in China is the support of the government's industrial policies, and the digital economy presents a complex and systematic nature that is constantly evolving (Chen, 2022). Therefore, this paper defines the digital economy as a new form of economic structure and operation mode changes caused by the continuous penetration of digital technology groups into various fields under the guidance of industrial policies, supported by the digital technology industry and connecting the Internet. Based on the connotation of the digital economy and the availability of data, this paper constructs a digital economy level index system from four dimensions, including digital economy policy environment, digital technology industry scale, Internet connection, and digital technology application, with a total of 9 subdivided indicators. Furthermore, the "Entropy-WASPS method" was used to measure the digital economy level of 30 provinces (municipalities and autonomous regions) in China except for Tibet from 2012 to 2020.

The mediating variable in this paper is the level of virtual agglomeration, including specialization and diversification. In this paper, the location entropy formula is used for measurement (Zhang et al., 2017), as shown in equations (4) and (5).

$$Medspe_{ijt} = \frac{D_{ijt} / D_{it}}{D_{jt} / D_{t}} \tag{4}$$

$$Meddiv_{it} = \left(1 - \frac{\left|Medspe_{ijt} - Medspe_{ipt}\right|}{Medspe_{ijt} + Medspe_{ipt}}\right) + Medspe_{ijt} + Medspe_{ipt} \tag{5}$$

In equations (4) and (5), *i*, *j*, *p*, and *t* respectively represent the region, manufacturing, productive service industry, and year, $Medspe_{ijt}$, $Meddiv_{it}$ represent the specialized and diversified virtual agglomeration level of regional manufacturing enterprises, $Medspe_{ipt}$ represents the specialized virtual agglomeration level of regional productive service enterprises, and D_{ijt} represents the level of digital technology application of regional manufacturing industry, D_{it} represents the level of digital technology application in all industries in the region, D_{jt} represents the national manufacturing digital technology application level, and D_t represents the level of digital technology application in all industries in the country.

The descriptive statistics of variables are shown in Table 1.

Table 1. Descriptive statistics of variables

Variables	Mean	St.d	Min	Max	N
Innout	4.951	1.427	0	11.09	11,538
Inneff	0.726	0.237	0.0008	1.001	11,538
De	0.384	0.266	0.0005	0.909	11,538
Rdt	17.905	1.496	5.094	23.491	11,538
Asset	23.132	1.175	17.806	27.547	11,538
As	0.414	0.365	0.008	31.467	11,538
Grow	0.649	17.438	-28.589	1,294.219	11,531
Roa	0.029	0.102	-3.2	1.408	11,538
Lnocf	19.205	1.584	10.506	24.668	11,538
Hc	0.175	0.024	0.099	0.222	11,538
Struc	1.376	0.847	0.611	5.244	11,538
Medspe	1.16	0.856	0	6.605	11,538
Meddiv	2.879	2.343	0.512	19.986	11,538

Notes: The data in the table is derived from the results of the operation in Stata.

Table 2. Basic results

Variables	Innout			Inneff		
	(1)	(2)	(3)	(4)	(5)	(6)
De	0.935***	0.531*	0.694***	0.065*	0.071*	0.087*
	(0.307)	(0.282)	(0.275)	(0.036)	(0.043)	(0.045)
Controls	NO	YES	YES	NO	YES	YES
Fix Industry	NO	NO	YES	NO	NO	YES
Fix Year	NO	NO	YES	NO	NO	YES
Observations	11,538	11,531	11,531	11,538	11,531	11,531
R^2	0.006	0.394	0.492	0.006	0.03	0.107

Notes: The data in the table is derived from the results of the operation in Stata. The superscripts ***, **, * are significant at the level of 1%, 5%, and 10%, respectively. The standard errors are in parentheses.

4. Results

4.1. Preliminary Regression

The regression results of the digital economy affecting the technological innovation of manufacturing enterprises are shown in Table 2. Among them, the explanatory variables in columns 1 to 3 are the technological innovation output of manufacturing enterprises, and the explanatory variables in columns 4 to 6 are the efficiency of technological innovation of manufacturing enterprises. It can be seen that regardless of whether control variables, industry-fixed effects, and time-fixed effects are added, the digital economy has a significant

positive impact on the technological innovation output and efficiency of manufacturing enterprises, indicating that the development of the digital economy promotes the technological innovation of manufacturing enterprises.

4.2. Test of Robustness

First, this paper tests robustness by substituting the explanatory variables. To test the robustness of the impact of the digital economy on the technological innovation output and efficiency of manufacturing enterprises, the number of applications of the invention patent is used as a measurement index for the technological innovation output of manufacturing enterprises. The ratio of the number of patent applications to the logarithmic amount of research and development investment is used as a measure of the efficiency of technological innovation of manufacturing enterprises. Second, this paper tests robustness by substituting explanatory variables. The early form of the digital economy was mainly based on electronic commerce. Therefore, this paper uses the logarithmic values of electronic commerce transaction volume in 30 provinces (municipalities and autonomous regions) in China except for Tibet as the core explanatory variable to replace the original digital economy index. The regression results of replacing the explained variables and core explanatory variables show that the digital economy does have a significant positive impact on the output and efficiency of technological innovation of manufacturing enterprises.

4.3. Analysis of Heterogeneous

(1) Heterogeneity of the industry to which the enterprise belongs. High-tech manufacturing includes pharmaceutical manufacturing, aviation, spacecraft and equipment manufacturing, electronic and communicating equipment manufacturing, computer and office equipment manufacturing, medical equipment manufacturing, instrumentation manufacturing, and information chemical manufacturing, and the rest of the manufacturing industries are medium and low-tech manufacturing. Therefore, this paper regresses the samples of high-tech manufacturing enterprises and medium- and low-tech manufacturing enterprises respectively, and the results are shown in Table 3. It can be seen that in the sample of high-tech manufacturing enterprises, the digital economy has promoted technological innovation efficiency, but has not promoted technological innovation output. In the sample of medium and low-tech manufacturing enterprises, the digital economy promoted the technological innovation output but did not have a significant positive impact on technological innovation efficiency. The possible reason is that the applied level of digital technology of high-tech manufacturing enterprises is relatively high, and the technological innovation output of enterprises depends more on human capital and capital investment within the enterprise, which is weakly affected by the development level of the digital economy, but the digital economy helps to accelerate the spillover of knowledge and technology, and enterprises can reduce the loss of technological innovation by obtaining technological innovation information, thereby having a significant positive impact on the technological innovation efficiency. For medium and low-tech manufacturing enterprises, the technological innovation output depends more on external human and financial support,

the digital economy is to accelerate the circulation of technological innovation factors for medium and low-tech manufacturing enterprises to provide resource-oriented support of technological innovation, accelerate technological innovation output, but due to the relatively low level of digital technology application of medium and low-tech manufacturing enterprises, high innovation losses may occur in the process of technological innovation, so the digital economy is difficult to have a significant positive impact on the technological innovation efficiency.

Table 3. Heterogeneous results of industry

Variables	High technology		Medium and low technology	
	Innout	Inneff	Innout	Inneff
De	0.572	0.154**	0.756**	0.046
	(0.402)	(0.064)	(0.371)	(0.065)
Controls	YES	YES	YES	YES
Fix Industry	YES	YES	YES	YES
Fix Year	YES	YES	YES	YES
Observations	5,155	5,155	6,376	6,376
R^2	0.505	0.114	0.476	0.727

Notes: The superscripts ***, **, * are significant at the level of 1%, 5%, and 10%, respectively. The standard errors are in parentheses.

(2) Heterogeneity of the region to which the enterprise belongs. In this paper, the sample of manufacturing enterprises is divided into four categories, eastern region, central region, western region, and northeast region. Among them, the eastern region includes 10 regions, the central region includes 6 regions, the western region includes 11 regions, and the northeast region includes 3 regions. The results of the regression are shown in Table 4. The digital economy has had a significant positive impact on the technological innovation output and efficiency of manufacturing enterprises in the eastern and central regions, while the western region and the northeast region have failed the test. This may be due to the greater policy support of the governments in the eastern and central regions for the digital economy, and the stronger development of the digital technology industry, which has improved the level of the digital economy, which in turn has promoted the technological innovation of manufacturing enterprises. However, the digital economy industrial policies in the western region and northeast region need to be improved, and the level of digital infrastructure is low, which makes it difficult to promote the technological innovation of manufacturing enterprises.

Table 4. Heterogeneous results of the region

Variables	Eastern region		Central region		Western region		Northeast region	
	Innout	Inneff	Innout	Inneff	Innout	Inneff	Innout	Inneff
De	1.12***	0.132**	0.166*	1.286***	-0.529	-0.692	2.507	0.072
	(0.354)	(0.066)	(0.085)	(0.407)	(1.384)	(0.294)	(1.945)	(0.47)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Fix Industry	YES	YES	YES	YES	YES	YES	YES	YES
Fix Year	YES	YES	YES	YES	YES	YES	YES	YES
Observations	7,656	7,656	1,906	1,906	1,439	1,439	530	530
R^2	0.501	0.121	0.532	0.51	0.51	0.131	0.607	0.396

Notes: The superscripts ***, **, * are significant at the level of 1%, 5%, and 10%, respectively. The standard errors are in parentheses.

(3) Heterogeneity of enterprise scale. According to the "Statistical Classification of Large, Medium, Small and Micro Enterprises (2017)" issued by the China Bureau of Statistics, manufacturing enterprises with operating income greater than or equal to 400 million yuan in this paper are classified as large manufacturing enterprises, and enterprises with less than 400 million yuan are classified as non-large manufacturing enterprise samples and returned separately. It can be seen from the results of Table 5 that the digital economy did not have a significant positive impact on the technological innovation output and efficiency of manufacturing enterprises in the sample of large manufacturing enterprises, and in the sample of non-large manufacturing enterprises, the digital economy had a significant positive impact on the technological innovation output and efficiency of manufacturing enterprises, possibly because the overflowing effects of technology and knowledge of the digital economy in non-large manufacturing enterprises were more obvious.

(4) Heterogeneity of enterprise equity. In this paper, the sample of manufacturing enterprises is divided into state-owned manufacturing enterprises and non-state-owned manufacturing enterprises, and regression is carried out separately. The regression results on the sample of enterprise equity heterogeneity in Table 5 show that the digital economy does not have a significant positive impact on the technological innovation output and efficiency of state-owned manufacturing enterprises, but has a significant positive impact on the technological innovation output and efficiency of non-state-owned manufacturing enterprises. This may be because the digital transformation goals and processes of state-owned enterprises are conservative and backward compared with non-state-owned enterprises, so it is difficult for the digital economy to promote the technological innovation of state-owned manufacturing enterprises, which is also the same as the research conclusion of Bo et al. (2022).

Table 5. Heterogeneous results of scale and equity of manufacturing enterprises

Variables	Heterogeneity of scale				Heterogeneity of equity			
	Large		Non-large		State-owned		Non-state-owned	
	Innout	Inneff	Innout	Inneff	Innout	Inneff	Innout	Inneff
De	0.413	0.078	2.529***	0.239**	0.78	0.082	0.84**	0.063**
	(0.297)	(0.05)	(0.753)	(0.098)	(0.492)	(0.076)	(0.348)	(0.038)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Fix Industry	YES	YES	YES	YES	YES	YES	YES	YES
Fix Year	YES	YES	YES	YES	YES	YES	YES	YES
Observations	10110	10110	1421	1421	4131	4131	7400	7400
R^2	0.488	0.093	0.587	0.398	0.547	0.079	0.467	0.141

Notes: The superscripts ***, **, * are significant at the level of 1%, 5%, and 10%, respectively. The standard errors are in parentheses.

4.4. Test of Mechanism

In this paper, the mediating effects of specialized and diversified virtual agglomeration are tested separately, and the results are shown in Table 6. The regression results of columns (1) and (4) show that the digital economy has a significant positive impact on specialized and diversified virtual agglomeration, indicating that the digital economy accelerates the construction of regional informatization, networking, and intelligence, thereby promoting

the virtual agglomeration of manufacturing enterprises in cyberspace. With the rapid development of the digital economy, the level of specialized and diversified virtual agglomeration will continue to increase. The regression results of columns (2) and (5) show that the digital economy promotes the technological innovation output of manufacturing enterprises by accelerating respectively specialized and diversified virtual agglomeration. It shows that the digital economy enhances the spillover effect of knowledge of technological innovation through the exchange and cooperation of manufacturing enterprises within and between industries, accelerates the flow and sharing of resources of manufacturing enterprises, and thus promotes the technological innovation output of manufacturing enterprises. The regression results in columns (3) and (6) show that the digital economy does not improve the technological innovation efficiency of manufacturing enterprises by promoting specialized and diversified virtual agglomeration. The efficient measurement of technological innovation of manufacturing enterprises in this paper includes both the requirement of maximizing the expected output and the requirement of minimizing the non-desired output when given capital and manpower input, but the digital economy has not improved the technological innovation efficiency of manufacturing enterprises by accelerating specialized and diversified virtual agglomeration, which may be because although the digital economy has realized the rapid flow of various innovative resources through specialized and diversified virtual agglomeration, the utilization effect of manufacturing enterprises on technological innovation resources needs to be improved. Manufacturing enterprises may waste the resources of technological innovation in the process of technological innovation, resulting in the spillover effect of innovative resources brought about by specialized and diversified virtual agglomeration.

Table 6. Testing results of the mechanism

Variables	The mediating effect of specialized virtual agglomeration			The mediating effect of diversified virtual agglomeration		
		Innout	Inneff		Innout	Inneff
De	1.253***	0.537**	0.096**	1.487***	0.755***	0.088*
	(0.04)	(0.274)	(0.049)	(0.242)	(0.272)	(0.046)
Medspe		0.132*	-0.008			
		(0.075)	(0.019)			
Meddiv					0.018***	0.0005
					(0.007)	(0.001)
Controls	YES	YES	YES	YES	YES	YES
Fix Industry	YES	YES	YES	YES	YES	YES
Fix Year	YES	YES	YES	YES	YES	YES
Observations	11,538	11,538	11,531	11,538	11,538	11,531
R2	0.296	0.724	0.109	0.036	0.724	0.109

Notes: The superscripts ***, **, * are significant at the level of 1%, 5%, and 10%, respectively. The standard errors are in parentheses.

5. Discussion

This paper expands on existing research from the following three aspects: first, current scholars pay more attention to the impact of digital technology on the technological innovation of manufacturing enterprises (Tommaso et al., 2021; Christian et al., 2022),

ignoring the transformation of the digital economy to the organizational structure of manufacturing enterprises, and in the era of digital economy, accelerating knowledge spillover and reducing transaction costs through virtual agglomeration has become an important way for manufacturing enterprises to improve the level of output and efficiency of technological innovation. Second, the existing literature mostly measures the level of virtual agglomeration in an industry (Zhao et al., 2022), but virtual agglomeration includes both specialized virtual agglomeration within the industry and diversified virtual agglomeration between industries, and the measurement methods should be different. Third, the impact of digital economy on technological innovation of manufacturing enterprises varies among samples of different manufacturing industries, enterprise scales, regions, and equity types, and the existing literature is slightly insufficient in this regard (Zheng et al., 2022).

6. Conclusions and Recommendations

This paper concludes the following: First, the digital economy promotes the technological innovation output and efficiency of manufacturing enterprises, and hypothesis 1 of this paper is verified. Second, the role of digital economy in promoting the technological innovation output and efficiency of manufacturing enterprises is affected by the industry type, geographical location, enterprise scale, and equity nature of manufacturing enterprises. Third, the testing results of the mechanism show that the digital economy has a significant positive impact on specialized and diversified virtual agglomeration, and the digital economy promotes technological innovation output of manufacturing enterprises by accelerating specialized and diversified virtual agglomeration but does not improve the technological innovation efficiency of manufacturing enterprises, hypothesis 2 in this paper has not been fully validated.

This paper puts forward the following three policy implications: First, local governments should formulate strategies and plans for the digital economy that are in line with the actual development of regions, introduce diversified and incentive policies for the digital economy, and improve the constructing level of new digital infrastructure, to accelerate the development of the digital economy. Second, manufacturing enterprises should accelerate digital construction, and for state-owned manufacturing enterprises, senior managers should reach a consensus among them to accelerate the digital transformation of enterprises, establish the leading position of digital transformation on technological innovation of enterprise, and focus the digital transformation of enterprises on technological innovation of products and services; Non-state-owned manufacturing enterprises should do a good job in the training and management of digital technology talents, reduce the loss rate of digital technology talents, and make the digital economy better promote the technological innovation of manufacturing enterprises. Third, accelerate the construction of the industrial Internet platform, promote the specialized and diversified virtual agglomeration of manufacturing enterprises and productive service enterprises on the platform, realize the efficient flow of resources of technological innovation such as technology, talents, and capital in manufacturing and productive service industries, and improve the resource allocating of

technological innovation efficiency, to promote technological innovation of manufacturing enterprises; At the same time, the regulatory department of the platform should supervise the legality of the behavior of entities on the platform in real-time, and open multiple channels of supervision to ensure the healthy and sustainable development of the platform.

Conflict of interest: none

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Low-Carbon Transformation of China's Power Industry: Influencing Factors and Realization Path

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Abstract: The low-carbon transformation of the power industry is the decisive factor supporting the alteration and advancement of the whole society, and it is also an essential path to achieving carbon neutrality. To study the influencing factors of carbon dioxide emission in China's power industry, this paper first analyzes the influencing factors of contaminant discharge using a panel model. Secondly, according to the ratio of power production and power consumption, the provinces are divided into three regions: power "output" provinces, power "input" provinces, and power "balance" provinces to analyze the influencing factors under the different power provision and need structure. Thirdly, based on the pilot situation of the carbon trading market in China, it is divided into two phases: before the pilot and after the pilot to thoroughly investigate the effect of price level on contaminant discharge in the power sector. Finally, this paper puts forward the realization path of low-carbon transformation and provides policy recommendations for promoting carbon neutrality in the power industry.

Keywords: power industry; low-carbon transformation; panel model

JEL Classification: C33; Q42; L94

1. Introduction

In September 2020, China announced to the world that it will achieve carbon neutrality by 2060, which completely reflects the responsibility of a major country and further emphasizes the determination to make a green transformation. In the process of energy transformation, power energy gradually replaces fossil energy in the terminal energy sector, and the use scope of power is constantly expanding. Power will become the main terminal energy use mode, and the power industry has become the core of the entire energy system. The basic and pillar position of the power sector in the national economy is more stable. However, the rapid application of the power industry is also accompanied by high carbon emissions, which exceed 40% of total emissions, making it the main carbon emission sector. Therefore, power energy conversion is a decisive factor in supporting the transformation and development of society.

The research on the power energy conversion transformation focuses mainly on influencing factors analysis. The discharge of contaminant, i.e., carbon dioxide in the power industry is growing rapidly. What factors play a promotion role? What factors play an

inhibitory role? Furthermore, how to realize a smooth and steady transformation of the power industry? These issues have received extensive attention.

For influencing factors analysis, most of the literature uses factor decomposition methods to study. Malla (2009) used the LMDI (Logarithmic Mean Divisia Index) to conduct empirical research on the change in carbon dioxide emissions in seven countries in the Asia-Pacific and North America. Based on their research, Hou & Tan (2011) further decomposed the change of contaminant discharge in power production into five effects, including production structure, income effect, and others. Huo et al. (2013) also used this model to analyze and believed that the temporary fluctuations in contaminant discharge intensity mainly came from the changes in the generation side and delivery side. Wang (2005) argued that improving energy intensity could significantly reduce contaminant discharge. Chen et al. (2012) decomposed the carbon emission structure and calculated the contribution rate of different factors on low-carbon development based on the data of Guangdong province. They found the increase in provincial load was the main cause of the increase of electric power carbon emission in Guangdong province, and the modification of supply composition, the reduction of contaminant discharge intensity, and the application of gas units all contributed to the contaminant discharge decrease to varying degrees.

Some literature uses different model methods to analyze such problems. The empirical results of the error correction model built by Mi and Zhao (2012) showed that contaminant discharge and electricity expenditure are Granger causality. The same is true of electricity consumption and economic growth. Tang et al. (2018) assessed the impact of technological progress and energy structure transmutation on contaminant discharge by building a NET-Power model. In addition, based on the uncertainty of sustainable energy costs, combined with resource endowments and technology development trends, they constructed four scenarios to evaluate the environmentally friendly path in six regions. The results showed that the reduction of costs will have a greater impact on the space-time development of power generation technology and clean distribution between regions (Tang et al., 2019). The IO-SDA model results of Zhang and Guan (2019) indicated that the final demand scale and input-output are the most significant influencing factors, and they advocated helping the power industry reduce carbon emissions through optimization of production structure and upgrading of technology. The two-stage analysis results of Rodrigues et al. (2020) on the driving factors of contaminant discharge from power production in the EU showed that the change in fossil fuel usage combination, the improvement of production and use efficiency, and the application of renewable energy power will reduce contaminant discharge.

Numerous studies have explored the transformation path of the power industry. Some literature carried out multi-scenario simulation analysis through modeling and other methods to explore the emission reduction cost, emission reduction path, and technology selection of the power industry. Based on the NET-Power model, Tang et al. (2018) predicted that in China, the power industry in all regions except the eastern region would achieve the carbon peak by 2030. And they drew a detailed development path from the regional perspective. According to the development situation in different periods, Zhang et al. (2021) built a full chain technical and economic evaluation model for long-term analysis and built a

carbon emissions external cost planning model for short-term and medium-term analysis. They compared and analyzed the characteristics of the conventional path, electric hydrogen coupling path, and electric hydrogen carbon coupling path, and proposed that the future power system will present a low-carbon development trend of multi-path integration. Wu et al. (2021) used the coupling model of the power sector and terminal sector to forecast power demand, divided expectations into conservative expectation and positive expectation, and designed eight scenarios to study the path optimization and cost-effectiveness of transformation. Liu et al. (2021) compared the contaminant discharge intensity of gas electricity and coal electricity and found that under the two scenarios of heating and peak shaving, gas power has obvious advantages in carbon emission reduction. Therefore, natural gas can serve as a transition to ensure and promote the development of sustainable resources. Some literature explored the transformation path through cluster analysis. Qiu et al. (2022) proposed the power transformation path from a passive enabling system to an active enabling system through keyword cluster analysis. Lin and Yang (2022) analyzed the hotspots related to the transformation of the power system through the bibliometric method and pointed out the direction for future power system research in combination with existing research hotspots.

Most of the literature selects variables from a single perspective to analyze the influencing factors. Different from the existing studies, when using the panel model to analyze, this paper considers the power production side, power consumption side, and power market system, comprehensively and systematically investigating the impact of different factors. The innovation of this paper lies in dividing provinces into three regions: power “output” provinces, power “input” provinces, and power “balance” provinces to analyze the influencing factors under the different power provision and need structure, according to the ratio of power production and power consumption. Besides, based on the pilot situation of the carbon trading market in China, the influence of price level on contaminant discharge in the power sector is further studied in two stages: before and after the pilot. Finally, based on the results of empirical analysis, this paper proposes the path direction of transformation in the power industry.

2. Methodology

2.1. Variable Selection

When selecting the influencing factors, this paper finds that many related factors will have a direct or indirect impact, and different factors have different impact directions and degrees. This paper considers the factors from the aspect of the power production side, consumption side, and power market system.

From the power production side, select three indicators: power supply structure, the ratio of power generation and power consumption, and power supply coal consumption. The power supply structure is the percentage of thermal power generation in total. Power supply coal consumption is the average standard coal quantity required for each kilowatt hour of power provided by the thermal power plant. From the power consumption side, select three

indicators: economic scale, power intensity, and urbanization rate. The economic scale is measured by Gross Domestic Product (GDP). Power intensity refers to power consumption divided by GDP. It is an important indicator to reflect the power resources consumed per unit of GDP and reflect the utilization efficiency and dependence of economic development on power energy. The increase in power consumption intensity means the power energy consumption required to produce the same unit of output value increases. From the power market system, select the price level as an indicator, measured by the average sales price, to estimate the effect of the price mechanism.

This paper collects and collates the data on carbon emissions and their influencing factors in 30 provinces (except Tibet, Hong Kong, Macao and Taiwan) in China from 2005 to 2018. The data are from the Wind database, CEADs database, the National Bureau of Statistics, and the Electricity Power Yearbook. The power supply structure, the ratio, power intensity, and urbanization rate are all calculated from the collected data. The variables and their statistical description see Table 1-2.

Table 1. Description of variables

Index	Symbol	Unit	Meaning
Carbon emission	CO2	Million tons	Carbon emissions
Power supply structure	EPS	%	Percentage of thermal power generation in total
Ratio	EGR	-	Ratio of power generation and power consumption
Power supply coal consumption	PCC	g/kWh	Average standard coal quantity required for each kilowatt hour of power provided by the thermal power plant
Economic scale	GDP	yuan	Gross Domestic Product
Power intensity	EI	100 million kWh/100 million yuan	Power energy consumed to produce a unit of GDP
Urbanization rate	URB	%	Proportion of urban population in permanent population
Price level	PL	yuan/thousand kWh	Average sales price

Table 2. Statistical description of variables

Index	CO2	EPS	EGR	PCC	GDP	EI	URB	PL
Sample size	326	326	326	326	326	326	326	326
Mean value	144.3636	75.79806	1.053518	330.8887	18,343.23	0.12056	54.69016	548.0193
Median	104.9844	83.60941	1.00499	328	12,836	0.094836	53.21172	544.9
Maximum	560.1075	100	1.930218	469	99,945.2	0.552978	89.58333	777.24
Minimum value	8.206227	8.110157	0.328282	209	585.2	0.034507	27.45257	271.62
Standard deviation	112.9949	23.71975	0.304766	30.62794	17,201.49	0.080758	13.92628	118.1743

2.2. Data Processing

The results of the unit root test of each variable see Table 3. The first-order difference of variables is a stationary process.

Table 3. Unit root test

Variable	Fisher ADF test		Fisher PP test	
	Horizontal value	First-order difference	Horizontal value	First-order difference
lnCO2	43.1957	86.0403***	82.7753**	179.385***
lnEPS	76.7488*	112.247***	137.35***	290.56***
lnEGR	81.8898**	98.1729***	69.27	236.867***
LnPCC	59.0519	85.9815***	38.0843	230.552***
lnGDP	49.763	113.681***	58.5879	174.525***
lnEI	71.3801	223.111***	36.8593	315.845***
lnURB	47.9528	94.7629***	84.8654**	224.119***
LnPL	25.3479	97.897***	15.5904	146.408***

Note: *, ** and *** are significant at the level of 10%, 5% and 1%, respectively.

2.3. Model Construction

This paper systematically conducts influencing factors analysis through the following three models. Firstly, take all provinces as a whole, comprehensively investigate the impact of various influencing factors on the contaminant discharge from the national level, and record it as Model 1.

Secondly, due to the different matching of power supply and power demand in different regions, the provinces are divided into three types according to the ratio of power generation and power consumption of each province, namely, power “output” provinces, power “input” provinces and power “balance” provinces. The second model is built to conduct empirical analysis in regions with different power supply and demand structure, which is recorded as Model 2.

Thirdly, in 2011, China carried out pilot carbon emissions trading in seven provinces and regions, such as Beijing. The opening of the carbon trading market will cause changes in the production costs of the power supply industry. The operating costs of thermal power and renewable energy power will change to varying degrees. The cost changes will be transmitted to the power consumption side through the market price mechanism. Then, the consumer will adjust their choices in different types of power resources, ultimately affecting the carbon emissions. According to the time point of the pilot, the samples in the pilot area are classified into two groups. The first group is the period before the pilot, and the sample time is 2005-2011. The second group is the period after the pilot, and the sample time is 2012-2018. This is Model 3.

3. Results

The fixed effect model is used to estimate the elasticity coefficient of the influencing factors. The results of the three models see Table 4-6.

The test of Model 1 indicates that the price level has an inhibitory effect. Except for the price level, other factors, such as supply structure, power intensity, and urbanization rate all play a promoting role. Among them, power intensity has the largest promoting effect, with the elasticity coefficient reaching 3.05, followed by EGR, PCC, EPS, URB, and GDP.

In Table 5, the coefficient of the ratio in the three regions is positive at least at the significance level of 1%. But the elasticity coefficient of power “balance” provinces is significantly lower than that of power “output” provinces and power “input” provinces, which means that in regions where the power supply and demand structure is relatively

Table 4. Results of Model 1

Variable	Coefficient	t-statistic	P value
C	-10.60253***	-5.873035	0.0000
lnEPS	1.039982***	19.47037	0.0000
lnEGR	1.870823***	8.901386	0.0000
LnPCC	1.088637***	4.930911	0.0000
lnGDP	0.259453***	2.726804	0.0068
lnEI	3.050938***	8.476128	0.0000
lnURB	0.990734***	5.784599	0.0000
LnPL	-0.564026***	-4.142572	0.0000
Adjusted R2	0.982848		
F statistic	405.8615		

Note: *, ** and *** are significant at the level of 10%, 5% and 1%, respectively.

Table 5. Results of Model 2

Variable	Power "output" provinces	Power "input" provinces	Power "balance" provinces
C	-9.32429***	-10.72034***	1.403524
lnEPS	1.111404***	0.216124	0.584962***
lnEGR	1.928015***	1.959452***	0.993984***
LnPCC	0.924515*	1.675282***	0.086115
lnGDP	0.122824	0.266832**	0.615586***
lnEI	4.637364***	2.379266	1.50982**
lnURB	1.041988***	0.499011***	-0.461722
LnPL	-0.534909**	-0.16627	-0.758421***
Adjusted R2	0.958669	0.994099	0.996483
F statistic	108.691	731.0517	937.2827

Note: *, ** and *** are significant at the level of 10%, 5% and 1%, respectively.

Table 6. Results of Model 3

Variable	2005-2011	2012-2018
C	-14.43914**	-1.185123
lnEPS	0.928654***	0.514801*
lnEGR	1.946184***	1.629343***
LnPCC	1.431424**	0.798144**
lnGDP	-0.31106	-0.302716
lnEI	-6.602949	6.658765
lnURB	1.234585	1.570584***
LnPL	0.545303	-0.938564**
Adjusted R2	0.996884	0.998068
F statistic	520.8042	1,064.778

Note: Same as Table 3.

balanced, the promotion effect of the ratio is smaller. Therefore, realizing the balance of the power supply and demand structure will help decelerate the growth of contaminant discharge.

The results of Model 3 show that in the pilot area of the carbon trading market, the impact of power price is not significant before the pilot is opened. After the pilot is opened, the impact coefficient of power price is significant at least at the significance level of 5%. Every 1% increase in power price will reduce carbon emissions by 0.94%. The construction of the carbon trading market makes the impact mechanism of power price transfer to the power

consumption side more flexible through the market mechanism, and the path of realizing the transformation of the power industry through the price mechanism is more effective.

4. Discussion

Optimizing the power structure can reduce carbon emissions. The proportion of thermal power has a noticeable promoting effect. For every 1% increase in the proportion of thermal power, the carbon emissions will increase by 1.04%. Thermal power generation is still the primary origin of power, with coal-fired installed capacity accounting for almost half of the total. The combustion of coal energy will produce abundant carbon dioxide. With the total power generation unchanged, diminishing the percentage of thermal power provision, that is, optimizing the EPS, will reduce the contaminant discharge caused by coal combustion. Therefore, optimizing the power energy structure is an important path to effectively promote the transformation and development of the energy supply.

The ratio of power production and power consumption is an important indicator reflecting the regional transfer of power energy. The ratio has a promotion effect in the model. Every 1% increase in the ratio will increase the carbon emissions of the power industry by 1.87%, which is the second largest factor only next to the power intensity. Based on the results of Model 2, the promotion effect of the ratio is smaller in regions where the power supply and demand structure are relatively balanced. Therefore, realizing the balance of the power provision and need framework will help slow down the increase of contaminant discharge. Due to the absence of resources, the power generation capacity of Beijing, Tianjin, Shanghai, Zhejiang, and other places is not sufficient to meet their electricity demand. They need to rely on the power transfer from other provinces and belong to power “input” provinces. The demand for power transfer from other provinces will transfer the power production link with high carbon emissions to other provinces, reducing the carbon emissions of the province to a certain extent. On the contrary, for the power “output” provinces that bear more than the local power demand, the carbon emissions increased. Traditional centralized power supply has a high dependence on energy endowment, while new energy power generation technologies have a low dependence on energy resources. It is qualified to build a distributed power supply and the contaminant generated by the development and utilization of new energy is far less than thermal power generation. Therefore, under the general trend of developing new energy power, building a scattered provision system to improve the generation capacity of power “input” provinces, and reduce their demand for excess power in power “output” provinces is a viable measure. Moreover, improve the ratio in power “input” provinces, reduce the ratio in power “output” provinces, and ultimately promote the balanced transformation of all provinces.

Reducing the standard coal consumption per unit of power supply, that is, power supply coal consumption will help reduce carbon emissions. The PCC is a factor promoting pollutant release. Every 1% increase in power supply coal consumption will increase the contaminant by 1.09%. The power supply coal consumption reflects the usage of coal in the provisioning process and affects the coal resources consumed by each unit of power supply. The higher power supply coal consumption means the lower efficiency of thermal power generation and

utilization rate of coal. The low utilization rate is not only a serious waste of coal resources, but also increases the burden of carbon dioxide on the environment, and increases the difficulty of controlling carbon emissions. The power structure of China is led by thermal power at present. Therefore, reducing the power supply coal consumption and improving the efficiency of thermal power generation are technical difficulties that will be overcome in the development path, which are also vital measures to promote contaminant reduction.

The low-carbon economy development model is conducive to reducing carbon emissions. The economic scale promotes contaminant discharge. Every 1% increase in economic scale will increase the contaminant by 0.26%. GDP reflects the overall development level of the economy. The promotion effect of economic scale is reflected in the growth of power demand brought by economic growth. The higher the power demand, the more power production and corresponding carbon emissions. However, the positive driving effect of economic scale is the smallest among all influencing factors. This may be because in recent years, China no longer merely pursues the speed of economic growth, but pays more attention to the quality of economic growth. Relying on scientific and reasonable economic modes and advanced green technology, industrial development and green development are integrated to achieve high-quality growth. Therefore, based on new energy power, actively exploring a lower carbon development model is an essential path direction to curb the promotion effect of economic scale on contaminant discharge.

Reducing the power intensity and optimizing industrial structure can reduce carbon emissions. Among all the influencing factor indicators, the positive driving effect of power intensity is the most significant. Every 1% increase in power intensity will increase the contaminant discharge by 3.05%. The reduction of power energy required for the increase of unit GDP means the improvement of technology progress and terminal power utilization. The less power energy consumption is, the lower contaminant discharge will be. The power intensity is closely related to industrial structure. At present, China is carrying out industrial restructuring. The proportion of the secondary industry is declining, and its contribution to economic growth is also declining. But there are numerous high-energy consumption industries in the secondary industry, such as chemical manufacturing, steel, and cement manufacturing, and the decline in its demand for power energy cannot keep up with the decline in its contribution to economic growth. That is, the secondary industry has a large consumption of power energy and a small increase in GDP, indirectly increasing the power consumption per unit GDP, and increasing the burden of power intensity on the carbon emissions. Compared with the secondary industry, the tertiary industry has a small dependence on power energy and a significant contribution rate to economic growth, which can improve the utilization efficiency of terminal electric energy, indirectly decrease the power intensity, and thus reduce the discharge of contaminant.

The high-quality development of urbanization can reduce carbon emissions. The urbanization rate is a factor promoting pollutant release. Every 1% increase in the urbanization rate will increase contaminant discharge by 0.99%. The city is the gathering place of transportation, commercial activities, and industrial production, as well as the main concentration place of carbon emissions. The construction of basic facilities needs to consume

abundant power energy, and the demand for power energy in urban households is also higher than that in rural households. Therefore, the increasing urban population drives the demand for power demand and consumption and simultaneously intensifies the growth trend of carbon emissions. On the other hand, urbanization construction will also bring about industrial upgrading and technological progress, and improve the generation efficiency and utilization rate of the power industry. Therefore, when the urbanization level develops to a certain stage, the utilization rate of regional infrastructure will increase, the lifestyle of residents will also shift, the consumption mode will be greener, and the electricity demand will gradually decline, promoting the reduction of contaminant discharge. Consequently, the high-quality construction of cities and the guidance of residents' awareness of green consumption, the reasonable planning of the service life and efficiency of infrastructure, and the guidance of residents' green consumption and life will, to some extent, mitigate the promotion effect of the improvement of urbanization rate on the increase of contaminant discharge.

Intensifying the reformation of the power market and promoting the construction of the national carbon market can reduce carbon emissions. Every 1% increase in the price level measured by the average sales price will reduce the contaminant discharge by 0.56%. The power price affects carbon emissions by causing changes in power demand. Theoretically, the power price is a basic element of industrial production and people's life. Its change will certainly bring about the change of power consumption activities of various consumers, and then bring about the change of contaminant discharge. With the increase in the price level, the consumer will reduce the demand for electricity to a certain extent, pull down the consumption of primary energy by the supply enterprises, and naturally reduce contaminant discharge. Therefore, the price mechanism is the key to reducing carbon emissions. In addition, power price is also affected by the carbon market. The price fluctuation in the carbon market will bring about changes in the production cost of the power supply industry. The changes in the operating cost will cause changes in the power price level, and will also change the power supply industry's decision on the use of fossil energy and renewable energy, and ultimately affect the contaminant discharge level of the entire power industry. The results of Model 3 show that the construction of the carbon pilot makes the impact mechanism of power price transfer to the power consumption side more flexible through the market mechanism, and the path of controlling the contaminant level through the price mechanism is more effective. Therefore, the effective ways to control carbon emissions are to build a national unified power market system, better play the role of power price in regulating the supply and demand of power resources and promote the construction of the national carbon trading market.

5. Conclusions

Based on the three influencing factors analysis model, the power structure, the ratio, power supply coal consumption, economic scale, power intensity, and urbanization rate all have an obvious role in promoting the contaminant discharge of the power industry, while the price level has a restraining effect. To meet the new challenges under the goal of carbon neutrality, the power

production side, the power consumption side, and the power market system need to be significantly adjusted. From the above results, this paper proposes the following paths to achieve power green alteration.

First of all, the power supply structure needs to be significantly adjusted with energy alteration on the production side. Renewable energy and fossil energy are facing a role transition. Renewable energy power will gradually replace traditional fossil energy power as the basic power in the new era. The development trend of sustainable resources in the future is to use them nearby the user side, but it is faced with problems such as insufficient grid connection adaptability, low stability, and weak absorptive capacity. Therefore, the joint operation of distributed renewable energy generation and distributed energy storage is the direction of the new power supply system. Besides, renewable energy power generation can effectively decrease contaminant discharge. Although the withdrawal of coal power units is an inevitable trend, at this stage, renewable energy cannot completely replace thermal power. How to dispose of large and advanced coal power units is a key issue to be emphatically considered. In addition to the flexibility transformation of existing units, the use of existing units with CCUS (Carbon Capture, Utilization and Storage) technology is also a carbon neutrality road with Chinese characteristics.

Secondly, for the power consumption side, it is considered to discuss the green transformation in the context of industrial restructuring and urbanization construction. The power energy consumption per unit GDP has an enhancement effect on carbon emissions. Economic growth is highly dependent on power demand, and GDP growth is strongly related to contaminant discharge. At the same time, the power intensity is closely related to industrial restructuring. Therefore, manufacturing structure modernization is the key to realizing the decoupling of economic growth from the power demand and contaminant discharge. In addition, electricity is a basic component of urban infrastructure. The environmentally friendly transmutation of the electricity sector is inextricably linked with the low-carbon development of the city. The integration of the upgrading of the power system into the urbanization construction is a notable approach to reducing contaminant discharge.

Finally, the electrical system dominated by renewable energy is the key measure and inevitable requirement to realize energy transformation. The power market is a critical support for an innovative power system. At present, the power market still has problems of disunity, imperfection, incompleteness, and regional barriers in terms of transaction rules, functions, systems, and trans-regional transactions. To better perform the function of the market in power resource distribution and provide a strong market guarantee for energy transformation, it is necessary to improve the effective connection of power markets at different levels, better play the role of power markets with different functions, establish a unified trading order and technical standards, improve the market trading framework, break through the institutional barriers of trans regional power trading, and construct a unified national power market system. The specific measures to improve the power market system include improving the system and policy of renewable energy participating in energy provision, strengthening the price transmission procedure of the market with distinct functions, such as the spot market, and comprehensively handling the relationship between the carbon market and the national unified power market.

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Research on the Construction of Evaluation Index System for High-quality Development of Cultural Industry – Take 30 Provinces in China as an Example

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Abstract: Promoting the high-quality development of cultural industry, adapting to the transformation of the main social contradiction in the new era of China, and steadily improving China's cultural soft power and cultural competitiveness need to be supported by a scientific and reasonable index system for the high-quality development of cultural industry. This study uses the method of rooting theory to inductively deduce the guideline level elements reflecting the high quality development level of cultural industry in the new era, based on which the pathological index cycle method is used to screen the indicators of high quality development of Chinese cultural industry, and finally forms a comprehensive evaluation index system with four dimensions of industrial innovation, industrial coordination, industrial opening and industrial sharing as the primary indicators, eight corresponding categories as the secondary indicators, and 21 specific measurement indicators As a comprehensive evaluation index system of three-level indicators. Its policy significance is: it helps to grasp the overall situation of China's cultural industry development scientifically; it helps to realize the scientific policy of China's cultural industry; and it helps to realize the development goal of "unifying social and economic benefits".

Keywords: cultural industry; high-quality development; index system construction; pathological index method

JEL Classification: G11; F06; F12

1. Introduction

As a "green industry" and "sunrise industry", cultural industry is not only a driving force for economic development, but also a driving force for cultural development. At the same time, as an important path to relieve employment pressure and boost economic growth, the rise of cultural industry has positive strategic significance to improve comprehensive national power and economic vitality. Taken together, realizing the high-quality development of cultural industry is not only an objective requirement to adapt to the transformation of the main social contradiction in the new era, but also a necessary path to enhance cultural soft power and cultural competitiveness.

Studies on the high-quality development of cultural industry has been actively explored by the existing literature and a few research results have been achieved. The cultural industry

should focus on high-quality development, and Zheng (2019) and Zhang (2019) analyzed the path and mechanism of integration innovation to promote high-quality development of the cultural industry. Man (2018) and Wang (2018) analyzed the subdivided industries of the cultural industry. The existent studies simply equate the high-quality development of cultural industry with the improvement of total factor productivity, which obviously limit the whole picture of high-quality development of cultural industry. There is an urgent need to construct a set of multi-dimensional comprehensive index system that can scientifically and objectively reflect the connotation of high-quality development of cultural industry. Although the above-mentioned studies do not directly elaborate the evaluation indexes of high-quality development of cultural industry, their research methods and contents involve total factor production, integration and innovation, intellectual property protection and industrial talent cultivation, which are all important references for the evaluation indexes of high-quality development of cultural industry. Accordingly, this paper tries to make the following academic contribution, on the basis of defining the connotation of high-quality development of cultural industry, constructing a comprehensive evaluation index system with four dimensions of industrial innovation, industrial coordination, industrial opening and industrial sharing as primary indicators, eight corresponding categories as secondary indicators, and 21 specific measurement indicators as tertiary indicators, and adopting the pathological index method to make indicators of high-quality development of Chinese cultural industry further screening.

2. Theoretical Part

2.1. Definition of the Connotation of High-quality Development of Cultural Industry

High-quality development of cultural industries is very characteristic of China, so the connotation of high-quality development of cultural industries is mainly sorted out by the research of Chinese scholars. In studying the connotations, high-quality research is broadly based on two perspectives.

First, based on the five development concepts of innovation, coordination, green, openness, and sharing, high quality has a very rich connotation (Gao, 2020; Li & Wang, 2019), and it is believed that high quality development is an overarching concept, including the coordination and upgrading of economic structure and other aspects. Secondly, based on the concept that high-quality development should shift from "quantity" to "quality", it is believed that an important step of high-quality development is to stop expanding factor inputs and shift from unsustainable old kinetic energy to total factor productivity, which can continuously generate new power (He & Shen, 2018; Zhang & Liao, 2019).

Therefore, this paper defines the connotation of high-quality development of cultural industry as follows: Firstly, high-quality development of cultural industry is a new development concept, which is the development concept of "double-effect unification, social-effect priority" and "quality first, efficiency priority" that must be adhered to. Secondly, the high-quality development of cultural industry is a new development mode, which is digitalized, mixed and intensive development mode. Once again, the high-quality

development of cultural industry is a new development path, which is the systematic development path of modern cultural industry with creative innovation as the core and digital technology as the support.

2.2. Preliminary Construction of Evaluation Index System for High-quality Development of Cultural Industry

The cultural industry is a significant component of the industrial structure of the entire nation, and has become a new growth point and support point for promoting economic development in the industrial restructuring and transformation. As a key part of the industrial economy, the cultural industry is bound to be profoundly influenced from industrial organization, industrial development and industrial policies. Therefore, to build an evaluation index system for the high-quality development of China's cultural industry, it is necessary to take industrial organization theory, industrial development theory, industrial policy theory, etc. as guidance and adhere to the new development concept. Because of this, the initial design of the evaluation index system for the development of the cultural industry that was produced in this study is as follows.

Innovative Development of China's Cultural Industries

Innovation is the main driving force for the high-quality development of cultural industry, and is an important way to improve cultural confidence and promote cultural prosperity. For the construction of innovation dimension sub-indicators of cultural industry, this paper constructs 2 secondary indicators based on the guidance issued by the Ministry of Science and Technology on the national innovation capacity evaluation index system: ①Innovation resources. Innovation resources are the basis for innovation in cultural industry. The number of innovation subjects, their innovation consciousness and the stock of knowledge, technology and information they accumulate are important reflections of the level of innovation capacity of cultural industry in a region. ②Innovation performance. Innovation performance is an important indicator to measure the efficiency and effectiveness of innovation. For the measurement of innovation performance of cultural industry, it can be done in terms of innovation output such as innovation input funds, number of patents, number of new products, etc.

Coordinated Development of Cultural Industries in China

Coordination is an inherent requirement for the high-quality development of cultural industries. The high-quality development of cultural industry is inevitably the development of regional coordination and urban-rural coordination. Based on the existent research such as Yu (2021), this paper constructs three secondary indicators to measure the degree of coordination in the development of cultural industry: ①Resource coordination. Cultural resources indicate spiritual and cultural influence that generate direct and indirect economic returns to associated individuals, which is an important foundation for the development of cultural industry in a region and directly affects the development of local cultural industry. ②Urban-rural coordination. Urban-rural coordination is an important goal for the coordinated

development of cultural industry. The degree of coordination between urban and rural areas is mainly reflected by measuring the ratio of per capita cultural and entertainment consumption expenditure of urban and rural residents. ③Policy coordination. The difference of policy support for cultural industry in each region is an important factor leading to the unbalanced development of cultural industry. Generally speaking, the intensity of policy support for cultural industry is positively correlated with the level of cultural industry development. The higher the cultural industry policy support, the higher the level of cultural industry development.

Open Development of China's Cultural Industries

Openness is both the way to national prosperity and the way to high-quality development of the cultural industry. Openness is important for the productivity of cultural industries (Lv & Dong, 2018). It can be seen that the high-quality development of cultural industry must adhere to openness. Combining with the actual situation, this paper constructs 2 secondary indicators for measuring the openness of cultural industry: ①Inbound tourism. The status of inbound tourism is a reflection of the size of the international competitiveness of the cultural industry. ②Cultural exchange. Cultural exchange is positively correlated with the degree of openness of cultural industry. The more frequent the external cultural exchange, the higher the degree of openness; the sparser the external cultural exchange, the lower the degree of openness.

Shared Development of China's Cultural Industries

Shared development is the fundamental purpose of high-quality development. Cultural products are the fruits of reform and development, the fruits of common creation by the masses of the people, and should be shared by the masses of the people. Xi Jinping pointed out that "it is the essential requirement of socialism that the general public share the fruits of reform and development." Therefore, in the industry sharing dimension, this paper constructs a secondary indicator: access to cultural products and services. The people's common access to cultural products and services is the rightful meaning of shared development of cultural industries.

Thus, based on the principles of quantifiability, hierarchy and comparability, this paper builds an evaluation index system for the high-quality development of cultural industry by drawing on the index system construction method in China Cultural Industry High-Quality Development Index (2019), and constructs an evaluation index system for the high-quality development of cultural industry with four dimensions of industrial innovation, industrial coordination, industrial opening and industrial sharing as the first-level indicators.

In summary, the preliminary construction of the evaluation index system of high-quality development of cultural industry is shown in Table1.

In the process of constructing the above index system, the construction of primary indicators is based on the new development concept, the construction of secondary indicators is based on the reality and the research of scholars such as Yu(2021), and the tertiary indicators are obtained from the China Culture and Related Industries Statistical Yearbook, China

Table 1. Evaluation index system of high-quality development of cultural industry based on new development concept

Tier 1 Indicators	Secondary indicators	Tertiary indicators
Innovation	Innovative Resources	Investment in cultural industry innovation funds
		Innovation labor input intensity in cultural industries
		Density of employees in the cultural manufacturing industry
		Density of cultural manufacturing enterprises
	Innovation Performance	Production efficiency of new products in the cultural industry
		Invention patent output of cultural enterprises
		Copyright Acquisition for Cultural Enterprises
Coordination	Resource Coordination	Total number of artifacts in the collection
		Number of public cultural facilities
		Number of A-class scenic spots
	Urban-rural coordination	Ratio of per capita cultural and entertainment consumption expenditure of urban and rural residents
	Policy Coordination	General public budget spending on culture, sports and entertainment than
		Share of cultural expenses in financial expenditure
Open	Inbound Travel	Habitat tourism brand attraction
		Habitat tourism consumption attraction
	Cultural Exchange	Number of cultural exchange projects
		Number of participants in cultural exchange activities
Share	Access to cultural goods and services	Number of artifacts collected per capita
		Number of public library collections per capita
		Public library floor space for 10,000 people
		10,000 people have the floor space of mass cultural facilities

Culture and Cultural Relics Statistical Yearbook, China Statistical Yearbook, China Tourism Statistical Yearbook, China Financial Yearbook, and relevant industry reports and government websites.

3. Methodology

This part intends to use the "pathological index cycle analysis" method (Chen, 2019) to quantitatively screen the foreign trade quality development evaluation index system. Its advantage is that, on the one hand, the indicators that contribute to the overall information overlap of the index system are eliminated, so that the overall information overlap of the screened index system is very low; on the other hand, based on correlation analysis, the indicators with large information overlap between indicators are eliminated, so that the information overlap between the indicators of the screened index system is controllable. The specific steps are as follows.

3.1. Screening of Indicators Based on the Reduction of Overall Information Overlap

Step 1: Calculate the eigenvalues of the matrix of efficiency indicators for high-quality development of China's cultural industry.

First calculate the matrix by equation (1), the characteristic equation $X^{T}X$ of the eigenvaluesλ_1 ,λ_2 , , .λ_n.

$$|X^T X - \lambda_j E_n| = 0 \quad (1)$$

Step 2: Calculate the pathological index of the efficiency index of high-quality development of China's cultural industry.

Calculate the pathological index of n evaluation indicators SI_n:

$$SI_n = \sqrt{\lambda^* max / \lambda^* min} \quad (2)$$

Step 3: Calculate the pathology index after excluding individual indicators.

After eliminating the single index X_i, (i = 1,2,3,.....,n) of the index system of the high-quality development efficiency of Chinese cultural industry, the pathological index $SI_{(n-1)i}$ of the remaining $n-1$ measurement indicators is calculated. The pathological index $SI_{(n-1)i}$ of the remaining $n-1$ indicators was calculated successively according to equations (1) and (2).

Step 4: Calculate the overall information overlap contribution SI_n（i = 1,2,3,.....,n） of index X_i, (i = 1,2,3,.....,n).

$$SI_{i1} = SI_n - SI_{(n-1)i} \quad (3)$$

Step 5: Eliminate the indicators that contribute the most to the overall information overlap in the measurement index system.

$$S_{j1} = max[S_{i1}, 1 \le i \le n] \quad (4)$$

Stopping condition of information overlapping index screening: If the pathological index of all the remaining indicators is not greater than 10, the screening of information overlapping indexes will be stopped. Otherwise, follow the above steps to continue the screening of information overlapping indicators for the remaining indicators, and the cycle repeats until the pathological index of the remaining indicator set is no more than 10.

3.2. Indicator Screening Based on Reduced Information Overlap Between Individual Indicators

Based on the above pathological index cycle analysis, after screening the indicators with the goal of reducing the overall information overlap on the efficiency of high-quality development of China's cultural industry, the remaining indicators may have the problem of information overlap among individual indicators, and the information overlap indicators are further screened using the Person correlation coefficient matrix with the goal of reducing the information overlap among individual indicators.

Step 1: Calculate the Person correlation coefficient matrix between the *h* remaining indicators.

$$r_{ij} = \frac{\sum_{k=1}^{m}(x_{ki}-x_i^{'})(x_{kj}-x_j')}{\sqrt{\sum_{k=1}^{m}(x_{ki}-x_i^{'})^2(x_{kj}-x_j^{'})^2}} \quad (5)$$

According to the inter-indicator r_{ij} the Person correlation coefficient matrix R between the h remaining indicators was obtained.

$$R = (r_{ij})_{h \times h} \quad (6)$$

Step 2: Calculate the coefficient of variation of each measure.

$$cv_i = \sqrt{\frac{1}{m-1}\sum_{k=1}^{m}(x_{ki} - \frac{1}{m}\sum_{k=1}^{m} x_{ki})^2} / (\frac{1}{m}\sum_{k=1}^{m} x_{ki}) \quad (7)$$

Step 3: Eliminate measures with high information overlap between indicators Based on the Person correlation coefficient matrix R between indicators, we eliminate measures with high information overlap between indicators and reduce the higher information overlap between individual indicators. That is, if

$$|r_{ij}| > r_0 \quad (8)$$

This indicates that there is a high degree of information overlap between the measurement indicators and. Therefore, the one with the smaller coefficient of variation should be eliminated to avoid the problem of low overall information overlap in the high-quality development indicator system of the cultural industry, but still significant information overlap between individual indicators. In Eq. (8), the r_0 is the threshold value of information overlap screening among individual indicators. Obviously, the r_0 the larger the value is, the more significant the information overlap among individual indicators is reduced, but at the same time, the more indicators are eliminated and the more information is lost, which is not conducive to the comprehensiveness of the comprehensive measurement. Therefore, ther$_0$ the size of the correlation needs to be carefully weighed to determine, this paper based on the judgment criterion of correlation relationship, take r_0 = 0.9

On the other hand, based on the correlation analysis, we eliminate the indicators with large information overlap between indicators, so that the overall information overlap of the screened index system is low. On the other hand, based on the correlation analysis, indicators with large information overlap between indicators are excluded, so that the degree of information overlap between indicators in the screened index system can be controlled. Therefore, this method reduces the negative impact of overlapping information of indicators on the comprehensive measurement, and makes the constructed index system for measuring the high-quality development of Chinese cultural industry more scientific and reasonable.

4. Results

According to the construction principles of the evaluation index system, it has been possible to filter out the indicators we consider important through qualitative analysis and evaluation. However, the influence of some indicators on the evaluation results may in fact be weak, and only we empirically consider them important. In order to solve the possible problems, this part will further quantitatively screen the 21 indicators that have been qualitatively screened out as mentioned before.

4.1. Metric screening Based on Overall Information Overlap Reduction

(1) The first round of screening

First, according to the classification of 21 indicators in the qualitative analysis, the overall indicators were divided into four categories: "innovation", "coordination", "openness" and "sharing". "The pathological indexes of each indicator in each sub-category

were calculated separately by category. The sickness index of the "innovation" subcategory is 82.3393, the sickness index of the "coordination" subcategory is 41.4619, the sickness index of the "openness" subcategory is 9.4481, and the sickness index of the "innovation" subcategory is 9.4482. It can be seen that the morbidity indexes of all the subcategories except for the "open" subcategory are greater than 10, indicating that the overall information overlap of this measure is serious and should be dealt with. This indicates that the overall information overlap of this measure is serious and should be dealt with. Then, each indicator in each subcategory was eliminated in turn, and the morbidity index of the remaining indicators was calculated. The pathological indexes of the remaining indicators were obtained in a similar way as for the overall indicators by using the remaining indicators as a new indicator system.

Finally, the overall information overlap contribution of the indicators is calculated, and the indicators with a large overall information overlap contribution are excluded. The calculation results show that in the first round of screening of the index system, the indicators of "the intensity of innovative labor input in cultural industry", "the number of A-class scenic spots" and "the floor area of public libraries owned by 10,000 people" should be excluded. "The processing of all indicators in this part was done by MATLAB software, and the specific screening results are shown in the following table.

Table 2. First round screening of indicators

Indicators		Morbidity index	Pathological index after excluding Xi	Overall information overlap contribution of the indicator	Information Overlap Indicator Screening Results
Innovation	X1	82.3393	68.7063	13.633	Reserved
	X2		14.2872	68.0521	Remove
	X3		25.3607	56.9786	Reserved
	X4		16.6456	65.6937	Reserved
	X5		32.2735	50.0658	Reserved
	X6		29.564	52.7753	Reserved
	X7		24.5171	57.8222	Reserved
Coordination	X8	41.4619	33.5508	7.9111	Reserved
	X9		33.8576	7.6043	Reserved
	X10		32.1067	9.3552	Remove
	X11		40.8677	0.5942	Reserved
	X12		39.1166	2.3453	Reserved
	X13		37.7592	3.7027	Reserved
Open	X14	9.4481	4.4009	5.0472	Reserved
	X15		4.9296	4.5185	Reserved
	X16		4.283	5.1651	Reserved
	X17		5.4229	4.0252	Reserved
Share	X18	47.9388	29.5179	18.4209	Reserved
	X19		28.8508	19.0880	Reserved
	X20		6.2929	41.6459	Remove
	X21		39.0296	8.9092	Reserved

(2) The 2nd round of index screening

According to the above table, after a round of indicator screening, the pathological index of the subcategory "openness" is already below the level of 10, so it is not necessary to eliminate the indicators. However, the overall pathological index of the remaining indicators in the subcategory "innovation" and "coordination" is 14.2872 and 32.1067, respectively, after eliminating the indicators with high repetition, indicating that after eliminating the indicators X2 and X10, the overall pathological index of the remaining indicators is 14.2872 and 32.1067, respectively. Therefore, we need to start the second round of indicator screening for the subcategories of "innovation" and "coordination".

Similar to the screening process of the first round of the indicator system, the remaining indicators after elimination are treated as a new indicator system, both in the measure indicators with the elimination of the two indicators X2 and X10, each indicator is eliminated in turn, and the pathological index of the remaining indicators is calculated, and the overall information overlap contribution degree of the measure indicators is continued to be calculated, and the indicators with the overall information overlap contribution degree are eliminated. From the table, we can see that the three indicators X4 and X8 have the greatest overall information overlap contribution, so we continue to eliminate X4 and X8 on the basis of eliminating the previous indicators, and the results are as follows.

Table 3. Second round of screening of indicators

Indicators		Morbi-dity index	Pathological index after excluding X	Overall information overlap contribution of the indicator	Information Overlap Indicator Screening Results
Innovation	X1	14.2872	12.8317	1.4555	Reserved
	X2		/	/	Eliminated
	X3		12.3958	1.8914	Reserved
	X4		8.2488	4.0384	Remove
	X5		13.0055	1.2817	Reserved
	X6		13.5063	0.7809	Reserved
	X7		13.5743	0.7129	Reserved
Coordination	X8	32.1067	9.7404	22.3663	Remove
	X9		18.1860	13.9207	Reserved
	X10		/	/	Eliminated
	X11		29.9924	2.1143	Reserved
	X12		26.0106	6.0961	Reserved
	X13		14.6772	17.4295	Reserved

According to the above table, after the second round of indicator screening, the pathological indexes of the subcategories "innovation" and "coordination" are 8.2488 and 9.7404 respectively after the elimination of the indicators X2 and X8, both of which have dropped to below 10. The screening of indicators based on the overall information overlap has been completed, and a total of 5 indicators have been eliminated, and the index system for measuring the high-quality development of China's cultural industry has been reduced from 21 indicators to 16 indicators.

4.2. Indicator Screening Based on Reduced Information Overlap Between Individual Indicators

In order to avoid overlapping information among the remaining 16 measures, we need to further screen the overlapping indicators by using the Person correlation coefficient matrix with the goal of reducing the overlapping information among the individual indicators.

According to the data of each indicator, the Person correlation coefficient matrix of 16 indicators is calculated. According to the judgment criterion of threshold r_0=0.9, it is found that X3 is highly correlated with X14, and X18 is highly correlated with X6, X13 and X15, $r_{3,14}$=-0.9211, $r_{6,18}$=0.9673, $r_{13,18}$=0.9746, $r_{15,18}$=0.9497, the coefficients of variation of X3, X6, X13, X14, X15 and X18 were calculated respectively, and the results showed that cv_3=0.6002, cv_6=0.8454, cv_{13}=0.7209, cv_{14}=1.2581, cv_{15}=0.7605, cv_{18}=0.6214. According to the principle that the larger the coefficient of variation is, the more important the measurement index is, keep X6, X13, X14, X15, and exclude X3 and X18.

In summary, this paper eliminates 7 indicators from all 21 evaluation indicators of high-quality development of China's cultural industry based on the "pathological index cycle" method. The overall repetition degree is reduced, and the overlap of information between indicators is reduced, so that the comprehensive information repetition degree is reduced and the construction of the index system is more scientific and reasonable. The following table shows the evaluation index system of high-quality development of Chinese cultural industry after "quantitative screening".

Table 4. Evaluation index system of high-quality development of China's cultural industry

Tier 1 Indicators	Secondary indicators	Tertiary indicators
Innovation	Innovative Resources	Investment in cultural industry innovation funds
	Innovation Performance	Production efficiency of new products in the cultural industry
		Invention patent output of cultural enterprises
		Copyright Acquisition for Cultural Enterprises
Coordination	Resource Coordination	Number of public cultural facilities
	Urban-rural coordination	Ratio of per capita cultural and entertainment consumption expenditure of urban and rural residents
	Policy Coordination	General public budget spending on culture, sports and entertainment than
		Share of cultural expenses in financial expenditure
Open	Inbound Travel	Habitat tourism brand attraction
		Habitat tourism consumption attraction
	Cultural Exchange	Number of cultural exchange projects
		Number of participants in cultural exchange activities
Share	Access to cultural goods and services	Number of public library collections per capita
		10,000 people have the floor space of mass cultural facilities

5. Conclusions

High-quality development of cultural industries is an effective market-based development mechanism to achieve cultural prosperity and meet the growing spiritual and cultural needs of the people, as well as an important condition to enhance the international

communication power of Chinese culture, the global competitiveness of cultural industries and the comprehensive soft power of the country. It is urgent to build a set of evaluation systems that meet the connotation of high-quality development of cultural industry in order to assess the degree of high-quality development of China's cultural industry. The high-quality development of cultural industry has emerged as a major strategic proposition and an urgent practical demand. The creation of an assessment index system for the high-quality development of the cultural industries offers a quantitative tool for comprehending the state of the cultural industries' development and aids in the government's formulation of more rational and scientific cultural industries policies.

Conflict of interest: none.

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Economic Policy Uncertainty and Regional Innovation and Entrepreneurship Performance: An Empirical Analysis Based on 288 Cities in China

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Abstract: Does economic policy uncertainty affect the pace and nature of urban innovation and entrepreneurial performance and if so, by how much? In order to answer this issue, this study analyses China city panel data from 2003 to 2020 and experimentally analyze their relationship. The key findings are as follows: Initially, the unpredictability of economic policy can considerably boost urban innovation and entrepreneurship. Second, the unpredictability of economic policy has a detrimental influence on western cities, a positive effect on innovation and entrepreneurship in central and eastern cities, and no statistically meaningful result yet in the northeast. Thirdly, the unpredictability of economic policy might encourage innovation and entrepreneurship in places with a marketization rate of at least 75%. Fourthly, the uncertainty of economic policy has a positive influence on cities with an urbanization rate above 48.9% and a negative effect on cities with an urbanization rate below this threshold. Fifthly, the unpredictability of economic policy might impact regional innovation and entrepreneurship through changing the degree of urban financial development. On this basis, a proper local development policy framework will be formulated by merging various urban development endowments, and the degree of local financial development, marketization, and urbanization will be continuously enhanced.

Keywords: economic policy uncertainty; innovative entrepreneurial performance; mediating effect

JEL Classification: O11; O14; E00

1. Introduction

With the aggressive promotion of the "mass entrepreneurship and innovation" development plan, innovation and entrepreneurship have become crucial for the country to stabilize employment and achieve high-quality economic growth. Innovation and entrepreneurship are a dynamic development process that has undergone resource-driven, financial-driven, and innovation-driven development (Zhang et al., 2016), is influenced by cultural, institutional, economic, and other factors (Wang et al., 2018), and exhibits the characteristics of high uncertainty. Entrepreneurial performance may accurately reflect all the ultimate effects of entrepreneurial action (Endalew et al., 2020), and it is one of the most important markers in both empirical and theoretical study for determining whether a new

business grows healthily and swiftly (Chen & Mao, 2020). Focusing on innovative entrepreneurial performance allows one to comprehend the actual operation of entrepreneurial activities, which is crucial for promoting the dual-venture strategy more actively.

Government behavior and policies are the external factors that have the most direct effect on the production and operation activities of businesses, and the effectiveness of policy instruments has always been an important tool for local governments to support industrial development and enterprise innovation. However, economic policy uncertainty refers to the reality that economic agents are unable to precisely forecast whether, when, and how the government will alter its current economic policy (Gulen & Ion, 2016). Numerous academic researches have been conducted on economic policy uncertainty. Some researchers have found that the increase in economic policy uncertainty exacerbates the fluctuation of key macroeconomic variables and financial asset variables, thereby impacting the economic cycle (Villaverde et al., 2015; Pastor & Veronesi, 2012; Born & Pfeifer, 2014). This, in turn, will have a negative impact on macro variables such as output and employment, thereby impeding economic recovery (Baker et al., 2016). In addition, there are studies that imply the uncertainty of economic policies may influence the investment activities of businesses by altering their operating expenses, so restricting their investment (Jin et al., 2014; Wang & Song, 2014; Li & Yang, 2015).

This study seeks to elucidate the theoretical process underlying the influence of economic policy uncertainty on innovation and entrepreneurship at the urban level and conducts research from an empirical analysis viewpoint. Compared to previous research, this work makes the following contributions: The paper begins by explicating the theoretical mechanism through which economic policy uncertainty influences innovation and entrepreneurship, i.e., financial development. Second, it broadens the innovation-related research field. Existing literature on innovation and entrepreneurship focuses primarily on enterprise perspectives. This research seeks to assess the influence of economic policy uncertainty on urban innovation and entrepreneurship. Third, previous studies have mostly explored the impact of economic policy uncertainty on the behavior and process of innovation and entrepreneurship. However, no research has yet examined the impact of economic policy uncertainty on innovation and entrepreneurship from the standpoint of outcomes and if the influence of outcomes varies among areas. As a result, this article focuses on the outcomes of innovation and entrepreneurship, namely the performance of innovation and entrepreneurship, and examines the impact of economic policy uncertainty on it.

2. Research Assumptions

2.1. The Direct Impact of Uncertain Economic Policies on Regional Innovation and Entrepreneurship Performance

With the deepening of research on innovation and entrepreneurship, it is discovered that innovation and entrepreneurship are inextricably linked. Entrepreneurs rely on innovation to realize economic value, sustain their businesses, and foster company growth. It is the origin

of entrepreneurship. However, entrepreneurs achieve organizational innovation by integrating diverse social resources and directing the generation of knowledge. Consequently, the literature evaluation reveals that entrepreneurship and innovation mutually reinforce one another. Innovation drives economic growth. Innovation is the means by which businesses achieve market dominance and surplus profits. When enterprises are confronted with market competition and risks, they tend to accelerate innovation to increase market power under certain conditions (Aghion, 2005), whereas the unpredictability of economic policies heightens market risks, which may prompt enterprises to increase investment in innovation in order to retain or regain market power. Moreover, Knight (1921) noted that entrepreneurs are investors and decision-makers of their own invention activities, and that uncertainty is the primary source of corporate profits. If future developments can be forecast, corporate revenues will vanish, hence the existence of uncertainty may encourage business owners to spend more in innovation. Based on the analysis presented above, the following hypotheses are drawn:

Hypothesis 1. Economic policy uncertainty has a direct effect on the improvement of regional innovation and entrepreneurship performance.

2.2. The Indirect Effect of Economic Policy Uncertainty on Regional Innovation and Entrepreneurship Performance

When economic policy uncertainty increases, market players face greater financing constraints than in normal economic times (Ma & Hao, 2022). The uncertainty of economic policy intensifies the financing constraint of market participants through three channels: First, the increase of uncertainty of economic policy will affect the financing of market participants through the bond market. When economic policy uncertainty increases due to principal-agent and moral hazard, creditors will not only reduce borrowing but also increase risk premium (Francis et al., 2014), which makes it more difficult for market players to issue bonds. Second, the increase in economic policy uncertainty will affect the financing of market participants through the stock market. The increase in uncertainty of economic policy results in the increase of volatility of stock price, the decrease of information content of stock price and the increase of cost of financing by issuing stock (Pham, 2019). Third, the increase in economic policy uncertainty leads to a decrease in the expected cash flows of market participants and an increase in financing constraints. However, the degree of financial development can effectively reduce the financing costs and thus ease the financing constraints faced by market players (Rajan & Zingales, 1998). On the one hand, the degree of financial development can promote investment and improve the efficiency of capital use; On the other hand, a high degree of financial development can create economies of scale by creating financial instruments and expanding financial resources, reduce transaction costs and investment risks, broaden financing channels, and increase the supply of market capital to ease market financing constraints. At the same time, enterprises have a large number of financing needs in all aspects of the process of innovation and entrepreneurship, and a sound financial system can effectively meet these needs through the rational allocation of funds, while financial markets can provide financial support for enterprises to engage in innovative

activities with high risk and high return characteristics (Saint-Paul, 1992). Therefore, the higher a country's financial development level is, the larger its financial institutions and financial markets are, the more it can provide more capital and liquidity, provide more convenient financial services for market participants, optimize the allocation of resources, provide financial services for market participants at low cost, ease financing constraints, and thus promote innovation and entrepreneurship development.

Hypothesis 2. Economic policy uncertainty can enhance regional innovation and entrepreneurship through the level of financial development.

3.Research Design

3.1. Model Settings

Basic model settings. Based on the above theoretical analysis, the following model is established:

$$innoentr_{it} = \alpha_0 + \alpha_1 EPU_{it} + \alpha_2 X_{it} + x_t + x_i + \varepsilon_{it} \quad (1)$$

The explained variable $innoentr_{it}$ in model (1) represents the regional innovation and entrepreneurship of city *i* in the period of *t*. The core explanatory variable EPU_{it} represents the economic policy uncertainty index of city *i* in the *t* period. X_{it} is the collection of other control variables that affect regional innovation and entrepreneurship. x_t is a time virtual variable that reflects the time effect. x_i is a regional virtual variable that reflects the regional effect and ε_{it} is a random perturbation term. As the most important model fitting coefficient in this study, the positive and negative values and size of α_1 represent the direction and degree of the influence of economic policy uncertainty on regional innovation and entrepreneurship.

Intermediary effect model. As described in the preceding section on theory, economic policy uncertainty influences regional innovation and entrepreneurship indirectly through financial development level. In this study, the aforementioned theoretical analysis is evaluated using the model for testing the mediating effect:

$$med_{it} = \kappa_0 + \kappa_1 EPU_{it} + \kappa_2 X_{it} + o_{it} \quad (2)$$

$$innoentr_{it} = \gamma_0 + \gamma_1 EPU_{it} + \gamma_2 med_{it} + \gamma_3 X_{it} + \pi_{it} \quad (3)$$

Among them: med_{it} represents an intermediate variable.

3.2. Variable Design

Explained variable. In this paper, the innovation and entrepreneurship index are the explanatory variable. The China Regional Innovation and Entrepreneurship Index (IRIEC)compiled by the Enterprise Big Data Research Center at Peking University is chosen. The index combines big data thinking and technology, based on the three core elements of entrepreneur, capital, and technology, and uses the entire amount of enterprise information from 1990 to 2020 from the national industrial and commercial enterprise registration database to construct from five dimensions: the number of new enterprises, the attraction of foreign investment, the attraction of venture capital, the number of patent licenses, and the

number of trademark registrations. The China Regional Innovation and Entrepreneurship Index is multidimensional, objective, and real-time. It can objectively reflect the vitality and performance of innovation and entrepreneurship in various regions.

Explanatory variables. As the explanatory variable, Baker's et al. (2016) economic policy uncertainty index(epu) is utilized. The index was developed by Stanford University and the University of Chicago based on news coverage of the world's main economies. The China Economic Policy Uncertainty Index, for example, is created utilizing text retrieval and filtering techniques, with the South China Morning Post serving as a news item retrieval platform. In this work, the annual arithmetic mean is used to translate the monthly economic policy uncertainty into the yearly economic policy uncertainty.

Other variables. The main control variables selected in this paper are: the level of economic development (lngdp), level of government intervention in science and technology (fistec), industrial structure (stru) and human capital (hum).

The level of economic development (lngdp), which is an important driving force for the innovation and entrepreneurship. This paper uses the logarithmic GDP to measure. Level of government intervention in science and technology (fistec), as measured by the ratio of government expenditures on science and technology to gross domestic product, can directly stimulate innovation and entrepreneurial initiatives at the societal and corporate levels.

Industrial structure (stru). Currently, the majority of entrepreneurs begin their ventures in the service sector, or tertiary industry. Comparatively to the primary industry agriculture and the secondary industry, the service industry has a lower cost need and a greater variety of forms. China is currently experiencing an industrial shift, and the tertiary sector offers greater chances. Taking into account the saturation degree of the primary industry and the secondary industry as well as the state's support policy for the tertiary industry, this paper makes the industrial structure the control variable and uses the ratio of the added value of the tertiary industry to the secondary industry as the control variable index of the industrial structure.

The conclusion on the relationship between human capital and entrepreneurial rate is likewise complex. According to Schultz, human capital is embodied in human beings, generated through investments in human beings, and reflects the knowledge, skills, credentials, experience, and proficiency of individuals. It primarily invests in medical insurance, on-the-job training, formal education, adult learning programmes, and employment migration. Therefore, those with a greater amount of human capital will have greater expertise and experience. On the one hand, this makes it simpler for these individuals to obtain jobs and greater wages in the labor market, and they are more likely to be hired by others as opposed to starting their own businesses (Fritsch & Storey,2014). On the other side, it makes it simpler for such individuals to identify and exploit market openings in order to launch a firm. Even if people with greater human capital are not necessarily more likely to start a business, it may be simpler for them to succeed if they do. Fritsch (2006) used cross-sectional data from Germany to demonstrate that the quality of the labor force has a substantial influence on the development of new businesses. The empirical findings of

Audretsch and Fritsch (1994) indicate that the share of unskilled labor, which represents human capital, has a considerable negative effect on the entrepreneurial rate, regardless of whether the rate is calculated using the ecological technique or the labor market method. Based on the potential influence of human capital on the entrepreneurial rate, this article incorporates this variable into the model and measures human capital by the proportion of research and development personnel in the overall employed population.

Financial development level (findev) is an intermediary variable. As the banking industry is the dominant financial system in China, and the innovation and entrepreneurship performance studied in this paper is generally that microeconomic entities predominantly use bank loans as the main external financing source of enterprises, this paper refers to Wang Chao et al. (2018) and uses the ratio of local and foreign currency credit balance to GDP to measure the degree of financial development.

Marketization level (market), measured by the municipal marketization index in Fan Gang's report on the marketization index in China.

Urbanization level (urban): it is measured by the ratio of the permanent population of cities to the total population at the end of the year.

3.3. Data Description

Taking into account the availability and accuracy of the data, this study picks 288 prefecture-level cities from 2003 to 2020 as its research object. Except for marketization index, the majority of the data come from the Statistical Yearbook of China, the statistical yearbooks of prefecture-level cities, industrial enterprise databases, etc., and the linear interpolation method and near-annual average method are used to fill in some missing values. Explanatory variables and control variables lag behind the explained variables for one period, with the exception of year and area dummy variables. Table 1 displays descriptive statistics of variables used.

Table 1. Variables' descriptive statistics

VARIABLE	MEAN	STD. DEV.	MIN	MAX
INNOENTR	51.8905	27.9785	1.0239	100.0000
EPU	123.5069	30.8928	75.9957	165.7432
HUM	0.8999	0.5736	0.0750	9.6220
STRU	0.9408	0.5158	0.0800	5.3500
LNGDP	16.0961	1.1052	12.6690	19.7740
FISTEC	0.1953	0.0459	0.0200	0.4970
FINDEV	1.1623	0.4596	0.1168	3.5917
URBAN	50.1416	16.6593	7.8000	100.0560
MARKET	9.8827	3.1366	1.9586	19.6944

3.4. Data Sources

This article uses data related to the transformation and upgrading of the digital economy and industrial structure in 30 provinces in China from 2013 to 2018. The data comes from the official websites of the National Bureau of Statistics and the provincial statistical bureaus, China Statistical Yearbook, China Tertiary Industry Statistical Yearbook, China Information Yearbook, China Information Industry Yearbook, China Academy of Information and

Communications Technology, and industry and informatization-related research reports and published data, Statistical yearbooks of various provinces over the years, and China's digital economy development reports over the years. Due to data availability issues, Hong Kong, Macau, Taiwan and Tibet are not included.

4. Empirical Analysis

4.1. Benchmark Regression

The influence of economic policy uncertainty on innovation and entrepreneurship performance is examined by progressively adding individual effect and time effect to the panel regression model (1). When annual dummy variables are inserted for time-effect regression, the joint statistic F is very significant, suggesting that the model (1) has both individual and time effects; hence, the panel model with two-way fixed effects is chosen to continue the analysis. In order to strengthen the model's rigour and trustworthiness, the control variables that affect innovation and entrepreneurial performance are gradually incorporated for regression (Table 1). In addition, based on the P-value of the Hausman test, the original hypothesis that the model is a random effect model is strongly rejected, hence the two-way fixed effect model is selected for this study. The fixed effect model in column (5) indicates that the fitting coefficient of economic policy uncertainty is 0.369 when time, individual effect and other influencing variables are controlled, indicating that the regional innovation and entrepreneurship performance will increase by an average of 0.369 units for each unit of economic policy uncertainty. This indicates that, from the perspective of

Table 2. Benchmark regression results

VARIABLE	OLS	OLS	FE	FE	FE	RE
	(1)	(2)	(3)	(4)	(5)	(6)
EPU	0.141***	0.0577***	0.150***	0.0375***	0.369***	0.0378***
	(0.0049)	(0.0054)	(0.0019)	(0.0025)	(0.0165)	(0.0014)
HUM		1.292***		2.124***	0.0259	2.112***
		(0.0557)		(0.0488)	(0.108)	(0.0208)
STRU		-1.507***		-2.258***	-1.751***	-2.221***
		(0.516)		(0.470)	(0.479)	(0.131)
LNGDP		4.040***		-0.967***	-0.819**	-0.907***
		(0.456)		(0.343)	(0.324)	(0.103)
FISTEC		35.68***		9.050***	7.856***	9.256***
		(3.144)		(2.243)	(1.972)	(1.097)
TIME EFFECT	NO	NO	NO	NO	YES	NO
INDIVIDUAL EFFECT	NO	NO	YES	YES	YES	NO
HAUSMAN					4514.67***	
_CONS	145.6***	133.5***	144.6***	138.2***	122.1***	137.6***
	(0.624)	(0.968)	(0.230)	(0.643)	(0.886)	(0.570)
N	4608	4608	4608	4608	4608	4608
R^2	0.167	0.331	0.569	0.906	0.949	0.2528

Note: *, **, *** indicate significance at the statistical level of1%, 5%, and 10%, respectively; (2) the robust standard errors are in parentheses.

innovation and entrepreneurship outcomes, economic policy uncertainty has promoted innovation and entrepreneurship at the local level. The fact that businesses confront greater possibilities and challenges due to the unpredictability of economic policy is one probable explanation. Businesses rely on innovation to attain market dominance and higher profitability. Innovation tends to help both young and established businesses strengthen their market positions, which boosts regional entrepreneurship and innovation performance.

4.2. Endogeneity and Robustness Test

As economic policy at the national level is part of macro-policy, it is impossible for economic subjects to affect all macro-policies; hence, there is hardly any reverse causal relationship between urban innovation activities and economic policy uncertainty. In addition, all explanatory factors and control variables have a one-period lag in this paper's empirical analysis, which substantially eliminates the possibility of reverse causation. Moreover, the empirical research thoroughly controls the fixed effects of years and geographies, effectively avoiding endogenous difficulties caused by missing data. Referring to Fang et al. (2015), this paper adds the lag term of the explained variables to the regression equation to eliminate the possible influence of the correlation between the explained variables before and after (column 3), and finds that the significance of the explained variables remains unchanged. Moreover, by altering the sample's time interval from 2010 to 2020 (column 1) and substituting the explained variable with the per capita innovation and entrepreneurship index (column 2), the empirical findings indicate that the uncertainty of economic policy continues to have a significant effect on innovation and entrepreneurship performance.

Table 3. Endogenous and robustness test results

VARIABLE	(1)	(2)	(3)
EPU	0.0485**	0.0472**	0.0279***
	(0.0065)	(0.0241)	(0.0098)
HUM	0.134	0.284	0.0596
	(0.233)	(0.552)	(0.388)
STRU	-2.997**	-3.661***	-2.915***
	(1.327)	(1.339)	(1.011)
LNGDP	0.918	1.375**	1.006*
	(0.718)	(0.668)	(0.534)
FISTEC	-3.081	-6.552	-15.53**
	(9.014)	(9.177)	(6.904)
L.INNOENTR			0.307***
			(0.0272)
_CONS	57.66***	63.42***	48.14
	(3.079)	(4.957)	(129.6)
TIME EFFECT	YES	YES	YES
INDIVIDUAL EFFECT	YES	YES	YES
N	2880	4608	4608
R^2	0.007	0.013	0.112

Note: *, **, *** indicate significance at the statistical level of1%, 5%, and 10%, respectively; (2) the robust standard errors are in parentheses.

4.3. Heterogeneity Analysis

Heterogeneity analysis-based on region. Due to varying resource endowments across locations, the impact of economic policy uncertainty varies in many ways. As shown in Table 3, the uncertainty of economic policy has a substantial positive impact on the central and eastern regions, a major negative impact on the western cities, and a statistically insignificant impact on the northeast. Currently, against the backdrop of the industrial transfer from the eastern region to the central region and the strategy of the rise of the central region, the economic policy has a significant impact on the innovation and entrepreneurship activities in the central region. Consequently, the innovation and entrepreneurship performance in the central region is positively impacted by the uncertainty of the economic policy. The eastern region has a high level of economic development, a higher threshold for entrepreneurship, and requires more investment for innovation activities; therefore, it is less affected by the uncertainty of economic policies, whereas the innovation and entrepreneurship activities in the western region are negatively affected by the uncertainty of economic policies, which may be related to the relatively insufficient environment for innovation and entrepreneurship.

Table 4. Regional heterogeneity test results

VARIABLE	EAST	CENTRAL	WEST	NORTHEAST
	(1)	(2)	(3)	(4)
EPU	0.0307***	0.396**	-0.224**	-0.0897
	(0.0104)	(0.1912)	(0.1046)	(0.321)
HUM	0.120	0.133	0.138	0.393
	(0.141)	(0.183)	(0.175)	(0.263)
STRU	0.303	-2.620***	-1.283***	-1.955***
	(0.582)	(0.826)	(0.383)	(0.597)
LNGDP	-0.950***	-0.0803	-0.605	-1.389**
	(0.359)	(0.290)	(0.374)	(0.650)
FISTEC	-0.276	12.78***	5.855	-5.670
	(2.728)	(3.605)	(3.801)	(5.122)
_CONS	130.3***	116.0***	115.3***	130.3***
	(1.104)	(1.538)	(1.387)	(2.435)
TIME EFFECT	YES	YES	YES	YES
INDIVIDUAL EFFECT	YES	YES	YES	YES
N	1457	1380	1249	522
R2	0.967	0.975	0.957	0.938

Note: *, **, *** indicate significance at the statistical level of1%, 5%, and 10%, respectively; (2) the robust standard errors are in parentheses.

Heterogeneity analysis-based on marketization. Herrera-Echeverria et al. (2014) believe that economic liberalization provides a good external environment for entrepreneurs to engage in entrepreneurial activities and has a positive impact on entrepreneurial activities, whereas the degree of marketization is an essential indicator for measuring the level of market economy construction in a country or region. The less marketization there is in a country or region, the less flawless the system architecture of finance, legal system, economic freedom, product market, and factor market, and the greater the entrepreneurial risk. As shown in Table 4, if the degree of marketization is graded from high to low, the influence of economic policies on the degree of marketization below 75% is not statistically significant, but the value

demonstrates a clear decline. In addition, the lower the degree of marketization, the more the degree of influence, but the higher the degree of marketization, the greater the positive impact, that is, the greater the incentive degree of economic policy uncertainty for the city with a larger degree of marketization.

Table 5. Marketization heterogeneity test results

VARIABLE	10%	25%	50%	75%	90%
	(1)	(2)	(3)	(4)	(5)
EPU	-0.0122*	-0.0164*	-0.0086***	0.0312*	0.0820**
	(0.0071)	(0.0097)	(0.0014)	(0.0173)	(0.0404)
HUM	0.0649**	-0.312	0.0759*	0.0550	0.741***
	(0.0312)	(0.237)	(0.0441)	(0.0516)	(0.0300)
STRU	-5.635***	1.338	-1.173	-1.342	0.963
	(1.366)	(6.440)	(2.848)	(1.554)	(2.467)
LNGDP	-1.311	3.980**	0.178	0.510	-0.342
	(3.995)	(1.694)	(1.360)	(1.174)	(2.330)
FISTEC	-32.93**	-7.288	-1.006	-13.30**	-13.34**
	(15.63)	(10.92)	(15.09)	(5.94)	(7.87)
_CONS	60.77***	56.82***	60.72***	56.88***	61.74***
	(8.397)	(6.376)	(4.241)	(3.409)	(6.510)
TIME EFFECT	YES	YES	YES	YES	YES
INDIVIDUAL EFFECT	YES	YES	YES	YES	YES
N	327	513	946	968	563
R2	0.027	0.007	0.001	0.007	0.004

Note: *, **, *** indicate significance at the statistical level of1%, 5%, and 10%, respectively; (2) the robust standard errors are in parentheses.

Heterogeneity analysis-based on urbanization. As an input-output process, innovation requires all types of resources, such as human resources, material resources, information resources (comprising technical and commercial information), etc., and must interact with or trade with resource owners or related stakeholders. So where are the resources? How can we better communicate or conduct business with resource stakeholders? Regarding the first question, from the standpoint of cities and villages, urbanization is the urbanization of population, which means that cities and towns always have more entrepreneurial resources, which are more concentrated in cities. Regarding the second question, from the perspective of geographical location, proximity to the relevant stakeholders of resources in the spatial geographical location is unquestionably a major advantage for establishing contact or conducting business with them, and urbanization of population is an important means of promoting proximity to the relevant stakeholders in the spatial geographical location. For instance, the empirical findings of Audretsch and Fritsch (1994) demonstrate that whether entrepreneurship is measured using the ecological technique or the labor market method, population change has a considerable positive effect on the entrepreneurship rate. When examining the effect of regional entrepreneurial opportunity structure and creative social environment on women, black, and Hispanic entrepreneurs, Hackler and Mayer (2008) also addressed the influence of population shift. As seen in Table 5, the impact of economic policy uncertainty on cities with varying levels of urbanization varies. It has a detrimental impact

on cities with less than 48.9 percent urbanization and a favorable influence on those with more than 48.9 percent urbanization. This demonstrates that population urbanization naturally exerts both a pulling and a pushing influence on entrepreneurship, and that the lower the level of population urbanization, the lower the entrepreneurship rate. Population urbanization helps explain the disparities in regional entrepreneurship rates. The impact of population urbanization on the rate of entrepreneurship cannot thus be overlooked in light of China's current urbanization trend.

Table 6. Urbanization heterogeneity test results

VARIABLE	10%	25%	50%	75%	90%
	(1)	(2)	(3)	(4)	(5)
EPU	-0.0221*	-0.0212*	0.0125**	0.0136**	0.0118***
	(0.0131)	(0.0124)	(0.0058)	(0.0061)	(0.00095)
HUM	0.459***	1.250*	0.118**	0.0836	0.185
	(0.0898)	(0.740)	(0.0589)	(0.0290)	(0.0216)
STRU	-9.816***	-1.918	-1.014	-4.320**	-2.089
	(3.018)	(4.146)	(2.940)	(1.876)	(1.920)
LNGDP	-2.171	0.460	0.912	-0.618	1.994*
	(5.880)	(4.766)	(1.316)	(2.022)	(1.132)
FISTEC	0.416	-34.64*	-13.10	-19.51	7.160
	(37.14)	(20.00)	(14.50)	(15.69)	(6.382)
_CONS	51.25***	69.83***	54.72***	69.42***	69.87***
	(12.24)	(7.804)	(6.156)	(4.232)	(1.483)
TIME EFFECT	YES	YES	YES	YES	YES
INDIVIDUAL EFFECT	YES	YES	YES	YES	YES
N	327	513	946	968	563
R2	0.027	0.007	0.001	0.007	0.004

Note: *, **, *** indicate significance at the statistical level of1%, 5%, and 10%, respectively; (2) the robust standard errors are in parentheses.

4.4. Intermediary Effect

In accordance with the preceding theoretical study, the level of financial development is chosen as an intermediate variable to assess the effect of economic policy uncertainty on innovation and entrepreneurial performance. Table 6 provides the results. The level of financial development has served as an intermediary variable, according to Bootstrap. In particular, in columns (1) to (2), the fitting coefficients of economic policy uncertainty to financial development level and financial development level to innovation and entrepreneurship performance all pass the 1% significance level test, indicating that economic policy uncertainty does affect the innovation and entrepreneurship performance of cities via financial development level. In addition, every 1 unit increase in the impact degree of economic policy uncertainty can directly increase the level of innovation and entrepreneurship by 0.0384 units and the level of financial development by 0.0588 units, resulting in an indirect improvement of urban innovation and entrepreneurship performance of 0.0164 units (0.0588*0.279 ≈ 0.0164) and a total effect of 0.0548 units. About 29.93% of the total effect is accounted for by the indirect effect of financial development level on urban innovation and entrepreneurship performance.

Table 6. Mediating effect result

VARIABLE	FINDEV	INNOENTR
	(1)	(2)
EPU	0.0588***	0.0384***
	(0.00308)	(0.00959)
FINDEV		0.279***
		(0.0686)
HUM	0.0231***	0.0365
	(0.0016)	(0.107)
STRU	0.0825	-1.861***
	(0.0541)	(0.475)
LNGDP	2.432***	6.429***
	(0.577)	(1.875)
FISTEC	0.0329	-0.769**
	(0.0416)	(0.319)
_CONS	-3.118***	166.3***
	(0.353)	(0.820)
TIME EFFECT	YES	YES
INDIVIDUAL EFFECT	YES	YES
BOOTSTRAP	[0.0013 0.0060]	
N	4608	4608
R2	0.911	0.943

Note: *, **, *** indicate significance at the statistical level of1%, 5%, and 10%, respectively; (2) the robust standard errors are in parentheses.

5. Conclusions and Recommendations

5.1. Conclusion

This research empirically studies the influence and internal mechanism of economic policy uncertainty on urban innovation and entrepreneurship performance using urban panel data from 2003 to 2020. The key findings are as follows: Initially, economic policy uncertainty can considerably boost urban innovation and entrepreneurial performance. Second, the unpredictability of economic policy has a negative influence on western cities, while it encourages innovation and entrepreneurship in central and eastern cities. There are currently no statistically meaningful results in the northeast. Thirdly, the unpredictability of economic policy might encourage innovation and entrepreneurship in places with a marketization rate of at least 75%. Fourthly, the unpredictability of economic policy has a positive influence on cities with a population that is greater than 50 percent urbanised and a negative effect on cities with a population that is less than 50 percent urbanised. Fifthly, the unpredictability of economic policy might impact regional innovation and entrepreneurship through changing the degree of urban financial development.

This study found a positive correlation between economic policy uncertainty and innovation, which at first glance appears to be somewhat unexpected. However, when one considers the economic policies developed by the Chinese government during the country's rapid economic growth and the fact that innovation is driving China's economy into the "new normal," this conclusion is in line with reality. Uncertainty in economic policy is both a risk and an opportunity for businesses at the micro level. As a result, businesses take advantage

of the chance to expand R&D spending, consolidate or further reinforce their market dominance through technical innovation operations, and have access to greater profit and growth potential.

Although economic policy uncertainty has a selective impact on innovation activities from a macro perspective, overall, relevant departments are always working to create a favorable external economic environment to support businesses in better leveraging their innovative vigor. For instance, the appropriate ministries strengthen support for businesses with innovation potential through the use of government subsidies in order to enhance business operating environments and encourage businesses to engage in high-quality innovation activities. Another illustration is how the government continuously encourages the growth and improvement of the financial market, lowers the cost of financing the financial market, eases internal and external financial constraints on businesses, and fosters an environment that is conducive to enterprise innovation within the economic system.

5.2. Recommendations

Based on the above research conclusions, this study puts forward the following suggestions:

First of all, although the research results show that the uncertainty of economic policy positively affects the innovation input and output of enterprises, the rising uncertainty of economic policy will also bring negative effects. Therefore, when relevant departments frequently introduce or adjust economic policies to smooth economic fluctuations and enhance national innovation capability, they should weigh the impact of economic policy uncertainty on different economic activities. In addition, in order to minimize the negative impact of economic uncertainty, there must be a set of systems, such as market systems, full competition systems, property rights systems, contracts, especially equity contracts.

Secondly, the research results of this paper are instructive for the adjustment of innovation and entrepreneurship policies. At present, China's economy is in a "new normal" driven by innovation. Given that the uncertainty of economic policy has different impacts on innovation and entrepreneurship in different regions, different levels of marketization and urbanization of population, relevant departments should devote themselves to building a good external economic environment to help enterprises better exert their innovation vitality. For example, relevant departments should attach importance to the role of marketization and urbanization, and increase support for economic entities with innovation and entrepreneurship potential, so as to promote economic entities to carry out high-quality innovation activities. Furthermore, the uncertainty of economic policy can affect the level of financial development, thus affecting the development of urban innovation and entrepreneurship. Therefore, it is necessary to promote the development and perfection of financial market, reduce the financing cost of financial market, reduce the internal and external financial constraints of enterprises, and create a good economic institutional environment for enterprise innovation. When the uncertainty of economic policy changes, these measures, which are conducive to improving business conditions, will help to stimulate innovation.

Finally, relevant departments can make use of the selection effect brought by the rising uncertainty of economic policies and use effective economic policies and administrative means to optimize the industrial structure. Specifically, relevant departments can take external measures to influence the business conditions of enterprises, so that the development of economic environment is conducive to innovative enterprises. When the uncertainty of economic policy rises, with the cooperation of external measures, the response of those high-efficiency enterprises is to increase innovation, while those low-efficiency enterprises may choose to withdraw from the market because of rising costs. Eventually, the industry will be shuffled, and the overall innovation capability of the industry will be improved.

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Supervisor-Employee Relationship in Relation to Job Satisfaction

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Abstract: Job satisfaction plays an important role in job performance, positively influencing it. Successful companies should achieve maximal employee job satisfaction and therefore better performance of a company. Although many factors affect job satisfaction, it is needed to mention the supervisor (leader) – employee relationship. This study aims to determine whether the answers of non-supervisory and manager/supervisory employees differ in relation to job satisfaction and how individual groups evaluate the sub-questions focused on information about the relationship with supervisors and communication in the company. The available results indicate that there is a statistically significant difference between job satisfaction ratings between non-supervisory employees and manager/supervisory employees ($p = 0.0002$). When rating the supervisor-focused sub-questions, there were statistically significant differences between males and females in both work positions and then between males from non-supervisory and manager/supervisory employees.

Keywords: job satisfaction; employee; supervisor

JEL Classification: J16; J28; O52

1. Introduction

Job satisfaction is a concept that authors have been dealing with for many years and many definitions for job satisfaction were used (Locke, 1976; Cook et al., 1981; Robbins, 2005; Gupta et al., 2014; Lu et al., 2012; Qureshi & Hamid, 2017; Roberts & Meredith, 2020). The job satisfaction concept expresses how much a given person is satisfied with her work. Job satisfaction is then related to performance, motivation, leadership, moral approach, life satisfaction, etc. (Abuhashesh et al., 2019; Parvin & Kabir, 2011). It has a significant place in the efficiency of business organizations because the satisfied employee (usually motivated to work) = happy employee = successful employee (with increased work performance) (Aziri, 2011; Raziq & Maulabakhsh, 2015). It was also found that "firms with higher employee satisfaction have a lower cost of equity" (Fu et al., 2023).

Job satisfaction is affected by several factors, in more recent literature e.g., Spector (1997) described extrinsic factors as working conditions (physical and social), job security and remuneration, and intrinsic factors as the relationship with colleagues, recognition, and advancement (Spector, 1997). A few years later other authors mentioned five aspects of job satisfaction (see Figure 1) (Tentama, 2020).

Figure 1. Job satisfaction model (own processing with the use of Tentama, 2020)

Although different authors talk about different aspects of job satisfaction, Spector's (1985) nine aspects of job satisfaction are often used – Pay, Promotion, Supervision, Benefits, Co-workers, Nature of work, and Communication (Spector, 1985).

Each aspect can be specified and if we focused on supervision, it "covers employees' perception, reaction, and emotion towards the supervision quality and leadership style of their leader" (Tentama, 2020). Supervision also includes a leader´s attention to employees or participation in the decision-making process (Tentama, 2020).

Supervision significantly affects job satisfaction (Mahlangu & Govender, 2015). The direct and indirect effect of supervision on job satisfaction was found, and it could be stated, that the better the supervision, the higher job satisfaction (job satisfaction can be increased by supervision) (Hidayatullah et al., 2020). The supervisor's behavior needs to be paid attention to in the company because it affects either work engagement and performance but workplace spirituality too (which has positive effects on burnout, well-being, and job satisfaction) (De Carlo et al., 2020).

This study aims to determine whether the answers of non-supervisory and manager/supervisory employees differ in job satisfaction and how individual groups evaluate the sub-questions focused on information about the relationship with the supervisor and communication in the company.

2. Methodology

Based on the literature research, two research questions were stated:

RQ1: Is there a statistically significant difference between the job satisfaction ratings of the SRE and NSRE groups?

RQ2: Does gender have an effect on the ratings of each supervisor-focused sub-question?

The study was conducted as a questionnaire survey. The survey was conducted between February and April 2021, a total of 1,334 answers were obtained. The paper form questionnaire was distributed among the students of combined study programs of the University of Hradec Králové, who work during their study. Therefore, many different fields of work were approached. The questionnaire was filled out by the students and their work colleagues whom the students approached.

The questionnaire was divided into three parts, the introduction contained questions focused on the organization's characteristics.

The second part of the questionnaire contained items related to organizational culture. Twenty-four-item questionnaire by Walach (1983) was used to determine organizational culture.

The third part was focused on job satisfaction (using 36 items). Spector's (1985) instrument was used, and each of the dimensions: Pay, Promotion, Supervision, Fringe Benefits, Contingent Rewards, Operation Conditions, Coworkers, Nature of Work, and Communication was assessed on a six-point scale (1 – strongly disagree, 6 – strongly agree). Overall job satisfaction is the average overall 36 items. The Czech version of the questionnaire is part of the publication Franěk and Večeřa (2008), this questionnaire is available on the Job Satisfaction Survey website (2018).

In relation to the aim of the study, we decided, among other things, to focus on evaluating five sub-questions (SQ1-5) from the questionnaire focused on the relationship with the superior worker or communication in a company. These sub-questions were:

SQ1: My supervisor performs the function competently.

SQ2: I think communication in our company is good.

SQ3: My supervisor is unfair to me.

SQ4: My supervisor hardly cares about the feelings of his subordinates.

SQ5: I like my supervisor.

For basic data analysis, descriptive statistics in the form of averages and correlation coefficients were calculated, for testing the correlation between the supervisor-employee relationship and the degree of job satisfaction. A t-test at the standard 5% level of significance and level 1% was used.

3. Results

A total of 1,334 answers were evaluated. Respondents were: men and women; aged from 16 to 81 years old; from different work fields; different work positions; from small, medium, and large enterprises. The detailed demographic profile of respondents is illustrated in Table 1.

Table 1. Respondent´s demographic profile (n = 1,334)

Gender	No.	%
Male	602	45.1
Female	732	54.9
Age		
Up to 25 years old	407	30.5
26-35 years old	343	25.7
36-45 years old	249	18.7
46-55 years old	271	20.3
56-65 years old	58	4.4
More than 65 years old	6	0.4
Size of organization		
Up to 50 employees	529	39.7
Up to 250 employees	319	23.9
Up to 500 employees	140	10.5
More than 500 employees	346	25.9

Among the areas that were most represented in the survey, we can mention, for example, healthcare, education, construction, engineering, administration, automotive industry, banking, tourism, transport, gastronomy, IT, trade, hospitality, or social work. The broad spectrum of respondents also included many underrepresented work areas, e.g., the tobacco or textile industry, printing, debt collection, fishing, hairdressing, and many others.

In terms of representation of the non-supervisory responsibility employee (NSRE) and manager/supervisory responsibility employee (SRE), there were a total of 308 (23.1%) SRE and 1026 (76.9%) NSRE involved in the study. The distribution of employees by gender and job position is shown in Figure 2.

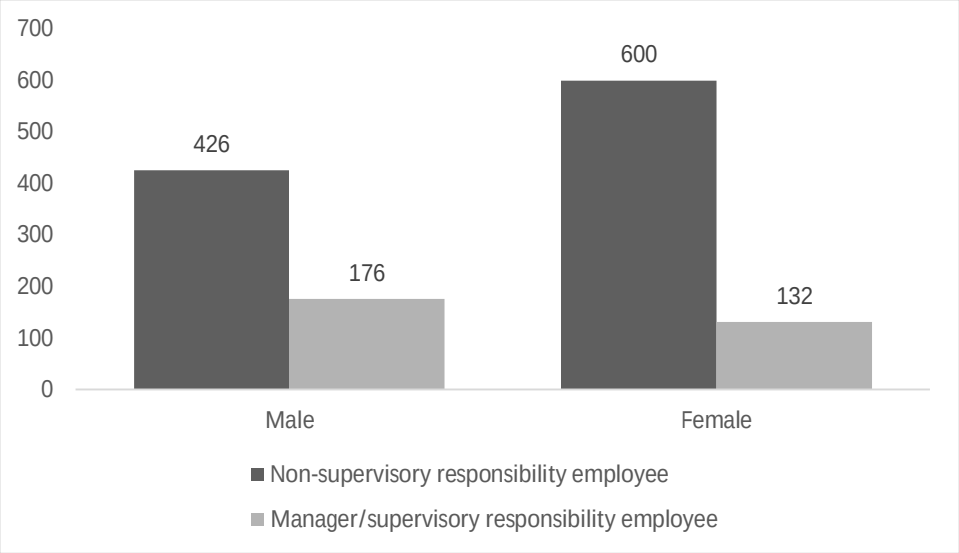

Figure 2. Proportional representation of SRE and NSRE by gender

If we compare the average rating of job satisfaction by NSRE and SRE in the t-test, at the level of significance alpha 0.01, there is a significant difference between the groups (the p-value = 0.0002).

When evaluating the individual sub-questions from the perspective of NSRE and SRE, the average values are in the range of greater than 4 (see Table 2). When comparing the responses of NSRE and SRE, it is evident that there is no significant difference between the two groups of employees. After conducting a t-test at alpha = 0.05 level of significance, there was no significant difference between the groups assessed (p = 0.166).

Table 2. Average rating of individual sub-questions

	NSRE	SRE
SQ1	4.55	4.49
SQ2	4.05	4.30
SQ3	4.55	4.61
SQ4	4.16	4.23
SQ5	4.27	4.37

When comparing the mean values of responses to the five sub-questions for SRE and NSRE respondents by gender, there is no significant difference between SRE and NSRE females (p = 0.32) after conducting a t-test. A significant difference at the alpha = 0.05 level

was observed between SRE males and females (p = 0.03), between NSRE males and females (p = 0.01), and also between SRE males and NSRE males (p = 0.05). Although statistically significant differences can be noted in the ratings, it must be stated that the individual questions were rated at a relatively high level, with only two cases where the average rating was less than 4. Concrete findings by position and gender are shown in Table 3.

Table 3. Average rating of individual sub-questions by gender and position

	Male SRE	Female SRE	Male NSRE	Female NSRE
SQ1	4.47	4.51	4.48	4.59
SQ2	4.29	4.30	3.97	4.10
SQ3	4.54	4.70	4.46	4.62
SQ4	4.18	4.29	3.99	4.28
SQ5	4.33	4.43	4.11	4.38

4. Discussion

Achieving sufficient work performance is very important for companies. At the level of the Czech Republic, job satisfaction, which is directly related to work performance, is measured at regular intervals using a questionnaire study (Frutos-Bencze et al., 2022; Zubr et al., 2016). Performance has then been investigated in the Czech Republic, e.g., by Hedvicakova and Kral (2021).

Many people spend a relatively large amount of time at work compared to the time at home. It is therefore important that employees are happy at work and enjoy their work. A motivated worker then does a better job, which benefits the company. Therefore, the goal of companies should be to provide an environment that leads to the highest level of employee satisfaction.

This study aimed to find out whether the answers of NSRE and SRE differ in relation to job satisfaction and how individual groups evaluate the sub-questions focused on information about the relationship with supervisors and communication in the company. Two research questions were stated.

Overall, 45.1% of men and 54.9% of women were included in the study. The age groups of workers under 25 and 35 were the most represented. Because we focused on NSREs and SREs, it should be noted that 23.1 SREs and 76.9 NSREs participated in the study. According to Weiss, 2018, in most areas are typical staff ratios of approximately 10 employees per manager, in an administrative area, the ratio is 20-to-1 and for direct reports to a senior manager or regional vice president the ratio is 4-to-1 (Weiss, 2018). In our study, there are theoretically approximately 3 NSREs per SRE, this ratio therefore roughly corresponds to the general representation in companies, which links the survey results in more to practice.

Firstly, the relation between the ranking of job satisfaction and the type of employee was tested. Based on the results obtained via t-test, we can answer the first research question:

RQ1: Is there a statistically significant difference between the job satisfaction ratings of the SRE and NSRE groups?

There is a statistically significant difference between the SRE and NSRE groups at the alpha = 0.01 level of significance on job satisfaction. The difference in ratings may be due to many factors, not only the amount of salary or various benefits, but also the fact that the SME

respondents may be members of the company's top management and, unlike regular workers, no longer have to answer to any supervisor. Then there is no one to motivate, task, and control their work performance, which can lead to their greater job well-being, life satisfaction, and job satisfaction than regular employees.

The second part of the Results is devoted to answering the second research question:

RQ2: Does gender have an effect on the ratings of each supervisor-focused sub-question?

Based on the results of this study, gender has a significant effect on the ratings of sub-questions. Previous studies focusing on gender and job satisfaction have had mixed results. E.g., Liu et al. (2021) did not find significant gender differences, Andrade et al. (2019) in their study found, that the same job satisfaction levels were found for both men and women, Miao et al. (2017) found gender differences in job satisfaction and job quality and Muskat and Reitsamer (2020) found out, that for Gen-Y, organizational type and gender influence the relationship between quality of work life-job satisfaction.

4.1. Limitations of the Study

A limitation of the study is that we do not know whether the superior employees are employees who report to other superior employees according to the company hierarchy, or whether they are high-ranking employees (e.g., CEO = owner) who do not have additional supervision.

5. Conclusions

Achieving satisfied employees should be the goal for every company, because satisfied employees not only bring benefits to the company and are essential to a company's performance, but also live a satisfied life, which is reflected in their work performance. That is why research into the factors that influence job satisfaction is still relevant. The evaluation of job satisfaction can vary not only across industries but also at different levels of employees in the company hierarchy. In this study, it was found that there is a statistically significant difference between the SRE and NSRE groups in rating overall job satisfaction and gender has a significant effect on the ratings of sub-questions focused on supervisor/communication in the company. In order to clarify the idea of the level of job satisfaction in the context of other countries, it would be beneficial if the survey was compared with the results of studies from neighboring European countries in the future. These results could serve as a basis for further research.

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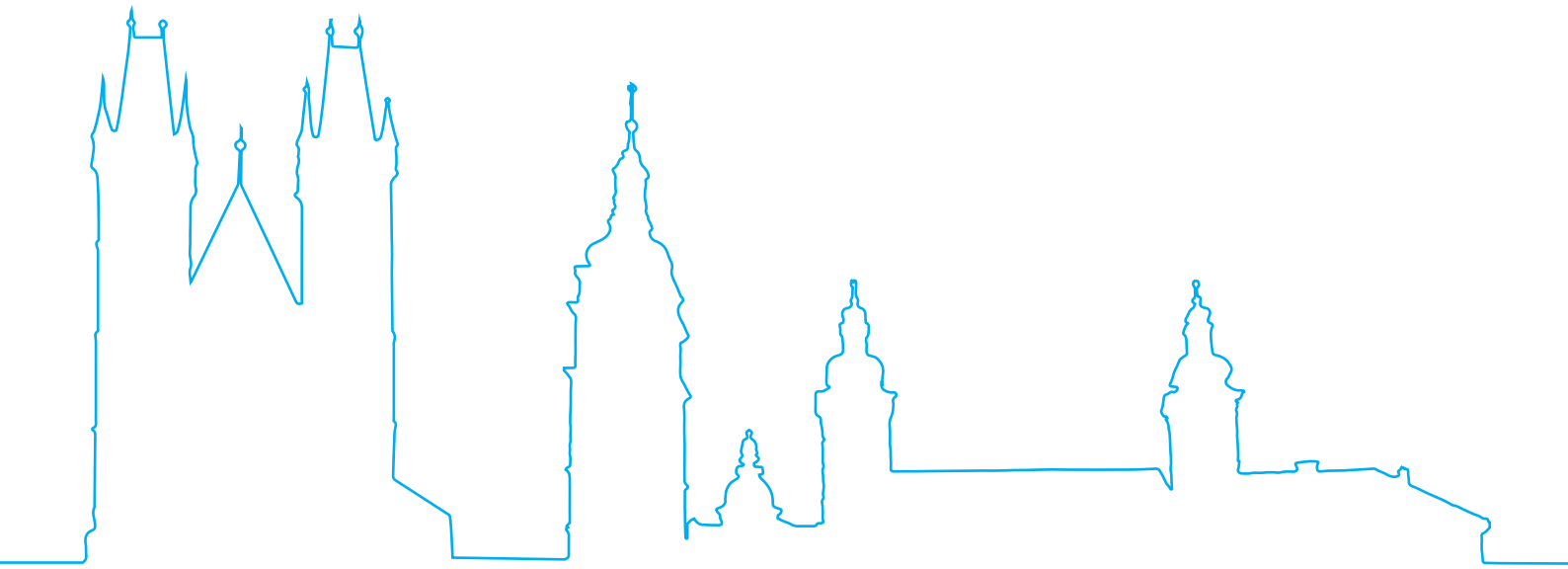

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