

# Hradec Economic Days

Vol. 9(1)

Double-blind peer-reviewed proceedings part I.  
of the International Scientific Conference  
Hradec Economic Days 2019

February 5–6, 2019  
Hradec Králové, Czech Republic

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University of Hradec Králové  
Faculty of Informatics and Management

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**Hradec Economic Days 2019**  
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Editors: Pavel JEDLIČKA, Petra MAREŠOVÁ, Ivan SOUKAL  
Publisher: University of Hradec Králové

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Proceedings were not a subject of a language check.

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**ISSN 2464-6059 (Print)**  
**ISSN 2464-6067 (Online)**  
**ISBN 978-80-7435-735-0**  
**DOI: 10.36689/uhk/hed/2019-01-000**

## Preface

Ladies and gentlemen, dear colleagues,

the Hradec Economic Days conference has been traditionally and continuously held since 2003. University of Hradec Králové organized the *17<sup>th</sup> Hradec Economic Days* conference in cooperation with the Wrocław University of Economics, the Cracow University of Economics and the Office of Transfer of Technologies at the University of South Bohemia. The conference was held from February 5 to February 6, 2019. It aimed to promote the idea of communication and cooperation of scientists from various fields with practitioners. The conference was in 2019 subtitled "Innovation and socio-economic development". This year conference scopes were to address following fundamental issues of:

- economic growth and employment, environmental and social challenges,
- changing roles of innovation, production, logistics, and service processes,
- innovative approaches to the management of operational processes,
- intellectual property rights,
- technology transfer and resource implications,
- financial innovations and focus on the consumer,
- new trends in the economy and its impacts on globalization.

Hradec Economic days conference has undergone dynamic development since the first year in both quality and quantity. The program committee also undergone fundamental change as well in favor of a substantial increase in the spectrum of international academicians from the USA, China, Malaysia, Spain, Croatia, Slovakia, Romania, Poland, and the Czech Republic. In 2019 we again cooperated with the MDPI publishing and two of their journals indexed in the Emerging Sources Citation Index (ESCI). The highest quality papers are to be revised for a possible inclusion in the special issue of *Economies* open access journal and the *Systems* open access journal published by MDPI. The best conference paper was awarded by 600 CHF price provided by the MDPI publishing.

All submitted papers undergone careful selection and were reviewed by 2-3 reviewers. We selected the best 113 papers in English that were published in two proceedings volumes. Authors of the conference papers are scientists and practitioners from the Czech Republic, Slovakia, Ukraine, Poland, Norway, China, Hungary, Mexico, Romania, and Denmark.

I am very pleased we succeeded in indexation of the 2018 proceedings, and I firmly believe that the changes the conference has undergone will contribute to regular indexation also in the future. We are also grateful for a tradition of cooperation with the Czech National Bank representative. Moreover, this year's conference was held under the auspices of the Czech National Bank which also provided a panel discussion on the topic of "100 years of Czech koruna" anniversary.

I want to thank all who participated in organizing the conference: thank you for your high-quality work. My thanks also go to the authors for their trust and support, and I am looking forward to seeing you again at HED2019.

Hradec Kralove, January 5, 2019

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





## CONTENT

PREFACE.....	3
CITIZENS' ENGAGEMENT ON REGIONAL GOVERNMENTS' FACEBOOK SITES. EMPIRICAL RESEARCH FROM THE CENTRAL EUROPE <b>Pavel BACHMANN</b> .....	9
SUSTAINABLE DEVELOPMENT IN THE POLISH-CZECH CROSS BORDER AREA - INDICATORS ANALYSIS <b>Bartosz BARTNICZAK</b> .....	19
COMMONALITY IN LIQUIDITY MEASURES. THE EVIDENCE FROM THE POLISH STOCK MARKET <b>Barbara BĘDOWSKA-SÓJKA</b> .....	29
MODELS AND FORECASTS OF WAGE DISTRIBUTIONS IN CZECH EDUCATION AND HEALTH CARE SECTORS <b>Diana BÍLKOVÁ</b> .....	41
ARE WAGES IN CZECH EDUCATION AND HEALTH CARE SECTORS THE SAME? <b>Diana BÍLKOVÁ</b> .....	53
OPTIMIZATION OF COMMUNICATION PRINCIPLES IN MULTI-AGENT ECONOMIC SYSTEM <b>Petr BLECHA</b> .....	65
GAMIFICATION AS AN INNOVATIVE IDEA WITHIN HUMAN RESOURCES MANAGEMENT <b>Jana BLŠTÁKOVÁ, Katarzyna PIWOWAR-SULEJ</b> .....	77
ECOLOGICAL POLICY IN THE SELECTED COUNTRIES OF THE EUROPEAN UNION <b>Michał BORYCHOWSKI, Sebastian STĘPIEŃ</b> .....	89
IMPACT OF SELECTED DETERMINANTS OF INNOVATION ON THE ECONOMIC GROWTH OF THE VISEGRAD GROUP COUNTRIES <b>Katarzyna BROŻEK</b> .....	101
HOW IS CORPORATE SOCIAL RESPONSIBILITY MEANT: ANALYSIS OF 100 DEFINITIONS <b>Simona ČINČALOVÁ, Martin PROKOP</b> .....	112
STRATEGIES OF KNOWLEDGE SHARING IN FARMS KEEPING CONSERVATIVE BREED LIVESTOCK <b>Marta DOMAGALSKA-GREDYS</b> .....	121
THE APPLICATION OF IOT IN THE AREA OF DETECTION <b>Petr DOUCEK, Milos MARYSKA, Lea NEDOMOVA</b> .....	128
THE INFLUENCE OF THE LABOUR MARKET ON THE DEVELOPMENT OF CREATIVE PROFESSIONS IN SECTOR CREATIVE <b>Karolina DRELA, Aneta SOKÓŁ</b> .....	135

MACRO EFFECT OF CORPORATE SOCIAL RESPONSIBILITY: BASED ON THE PERSPECTIVE OF THE HIGH QUALITY OF ECONOMIC GROWTH	
<b>Ying DU, Zhixin XUE, Hua YOU</b> .....	144
MACROECONOMIC ASPECTS OF LOW EMISSION LIMITATIONS IN THE LUBUSKIE VOIVODSHIP	
<b>Maciej DZIKUĆ, Maria DZIKUĆ</b> .....	156
CARBON – TO TRADE OR TAX – THAT’S THE QUESTION!	
<b>Anders EKELAND, Rong KANG, Jaroslav KOVÁRNÍK</b> .....	166
ANALYSIS OF DECOUPLING EFFECT OF CHINA'S AGRICULTURAL CARBON EMISSION	
<b>Xu FANG, Yanni LIU</b> .....	176
MULTI-CRITERIA AND DYNAMIC BRAESS'S PARADOX IN NETWORK SYSTEMS	
<b>Petr FIALA</b> .....	189
PROFITABILITY CONDITIONS OF THE SELECTED COMPANIES FROM THE WIG FOOD INDUSTRY INDEX IN 2011-2018	
<b>Chrystian FIRLEJ, Sebastian KUBALA</b> .....	194
STRUCTURAL TRANSFORMATIONS OF AGRICULTURE IN POLAND IN THE YEARS 2006-2016	
<b>Krzysztof FIRLEJ, Mateusz MIERZEJEWSKI</b> .....	203
DEVELOPMENT OF THE VENTURE CAPITAL MARKET AGAINST THE SELECTED WORLD COMPETITORS	
<b>Krzysztof Adam FIRLEJ</b> .....	215
KALMAN FILTER AND TIME SERIES	
<b>Kateřina FRONČKOVÁ, Pavel PRAŽÁK</b> .....	225
TAX COSTS RELATED TO FUNCTIONING OF SELECTED INTANGIBLE ASSETS	
<b>Łukasz FURMAN, Witold FURMAN</b> .....	235
BARRIERS TO THE DEVELOPMENT OF CONSUMPTION SUSTAINABILITY: THE CONSUMERS’ PERSPECTIVE ON THE FOOD MARKETS	
<b>Elżbieta GORYŃSKA-GOLDMANN</b> .....	243
INDUSTRY 4.0 MARKET IN POLAND FROM THE INTERNATIONAL PERSPECTIVE	
<b>Karolina GRZYB</b> .....	252
COMPARISON OF CURRENT BUSINESS ENVIRONMENT IN THE CZECH REPUBLIC AND POLAND	
<b>Eva HAMPLOVÁ, Anna CIERNIAK-EMERYCH, Szymon DZIUBA</b> .....	263
SINGLE MINUTE EXCHANGE OF DIE AND INNOVATIONS ARE JOIN VESSELS	
<b>Frantisek HASEK, Hana MOHELKA</b> .....	273
FINANCIAL MANAGEMENT IN CZECH ENTERPRISES DEPENDENT ON THEIR SIZE	
<b>Irena HONKOVÁ</b> .....	281

INTEREST EXPENSES AS A TECHNIQUE OF PROFIT SHIFTING USED BY SLOVAK COMPANIES	
<b>Michal IŠTOK, Mária KANDEROVÁ</b> .....	292
CLUSTER POLICY BASED ON KEY NATIONAL CLUSTERS – A CASE OF POLAND	
<b>Anna H. JANKOWIAK</b> .....	305
FACTORS INFLUENCING INVESTORS’ DECISIONS IN POLISH COMPANIES AS DEMONSTRATED BY RFID SYSTEMS	
<b>Marzena JANKOWSKA-MIHUŁOWICZ, Katarzyna CHUDY-LASKOWSKA</b> .....	317
COLLABORATIVE CONSUMPTION IMPACT ON TOURISM GROWTH AND SUSTAINABLE CITY DEVELOPMENT	
<b>Daria JAREMEN, Elżbieta NAWROCKA, Michał</b> .....	329
SECTORS IN THE CZECH REPUBLIC AND INTERNATIONAL TAX PLANNING	
<b>Vít JEDLIČKA, Pavel JEDLIČKA</b> .....	339
THE EFFECT OF A FACE ON PACKAGING FROM THE PERSPECTIVE OF MARKETING COMMUNICATION WITH OLDER CONSUMERS	
<b>Ewa JERZYK, Natalia WAWRZYNKIEWICZ</b> .....	348
MODIFIED POSITIONAL TOPSIS METHOD FOR ASSESSING THE SOCIO-ECONOMIC DEVELOPMENT LEVEL OF RURAL MUNICIPALITIES	
<b>Małgorzata JUST, Aleksandra ŁUCZAK</b> .....	357
ETHICAL DIMENSION IN THE EDUCATION OF FUTURE MANAGERS	
<b>Jaroslav KACETL, Ilona SEMRÁDOVÁ</b> .....	369
EDUCATIONAL ACTIVITIES OF AGRITOURISM FARMS IN POLAND	
<b>Marzena KACPRZAK, Katarzyna GRALAK, Izabela WIELEWSKA</b> .....	376
COMPARISON OF LIVING COSTS BY MEANS OF MONETARY MINUTE CURRENCY	
<b>Tomas KALA</b> .....	386
REGIONAL AID AND ITS IMPORTANCE IN THE CONTEXT OF TOTAL PUBLIC AID IN THE EUROPEAN UNION	
<b>Magdalena KOGUT-JAWORSKA</b> .....	397
MARKET ACTIVITIES IN THE AREA OF PRODUCT. A COMPARISON OF DAIRY COOPERATIVES FROM ŚWIĘTOKRZYSKIE AND MAŁOPOLSKIE VOIVODESHIPS	
<b>Izabela KONIECZNA</b> .....	406
DEVELOPMENT OF AGRICULTURAL INSURANCE IN THE RUSSIAN FEDERATION	
<b>Stanislava KONTSEVAYA, Grigoriy KONTSEVOY, Ludmila ADAMAYTIS</b> .....	415
RANKING SCORE OF FINANCIAL CONDITION AND FEAR OF BANKRUPTCY TO EVALUATE OPERATION’S CONTINUITY OF DAIRY MILK PROCESSING COMPANIES: EVIDENCE FROM THE REPUBLIC OF BELARUS	
<b>Stanislava KONTSEVAYA, Sergei CHACHOTKIN, Raisa KOSTINA, Ludmila KHORUZIY</b> .....	422
ACTIVITY BASED COSTING AND PROCESS SIMULATIONS	
<b>Martin KOPECKY, Hana TOMASKOVA</b> .....	431

SLOVAKIA AFTER THE INTRODUCTION OF THE EURO (OVERVIEW OF THE PERIOD 2009-2011)	
<b>Enikő KORCSMÁROS, Renáta MACHOVÁ, Zoltán ŠEBEN, Lilla FEHÉR.....</b>	<b>439</b>
SMART SPECIALIZATIONS IN POLAND AND THE CZECH REPUBLIC	
<b>Anna KOWALSKA, Jaroslav KOVARNIK .....</b>	<b>447</b>
IMPROVING SUPPLY CHAIN MANAGEMENT IN AN INTEGRATED PLANNING CENTRE	
<b>Arkadiusz KOWALSKI, Krzysztof MONASTYRSKI, Václav ZUBR .....</b>	<b>458</b>
IS INTERNET VOTING A WAY HOW TO IMPROVE COST-EFFICIENCY OF THE CZECH ELECTORAL SYSTEM?	
<b>Martin KRÁL.....</b>	<b>469</b>
INNOVATION AND SOCIO-ECONOMIC DEVELOPMENT OF SMART FURNITURES BY PATENT APPLICATIONS ANALYSIS	
<b>Ondrej KREJCAR, Petra MARESOVA, Ali SELAMAT, Sabina BARAKOVIC, Jasmina BARAKOVIC HUSIC, Signe TOMSONE.....</b>	<b>476</b>
SILVER ECONOMY AND THE DEVELOPMENT POLICY OF RURAL AREAS IN POLAND	
<b>Grażyna KRZYMINIEWSKA, Hanna PONDEL .....</b>	<b>487</b>
THE PREDICTION ABILITY OF NEW BANKRUPTCY MODELS IN NATIONAL ENVIRONMENT	
<b>Dana KUBÍČKOVÁ, Vladimír NULÍČEK .....</b>	<b>499</b>
REGIONAL DIFFERENCES IN ECONOMIC AND SOCIAL DEVELOPMENT IN POLAND - EVALUATION AND RECOMMENDATIONS	
<b>Joanna KUDEŁKO .....</b>	<b>509</b>
TRENDS AND STATUS OF AGRIBUSINESS IN ANIMAL HUSBANDRY OF THE RUSSIAN FEDERATION	
<b>Alfiya KUZNETSOVA, Marsel AVZALOV, Denis GOGBUNOV, Evgenii STOVBA .....</b>	<b>519</b>

# **Citizens' Engagement on Regional Governments' Facebook Sites. Empirical Research from the Central Europe**

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**Abstract.** Citizens' engagement is becoming a cornerstone for the next development of public administration. Nowadays, with a social media communication widespread, the public institutions and citizens relationship is challenged. Therefore, an article aims on the way of communication used by the government towards to citizens as well as the level of citizens' engagement. The study used a content analysis of Facebook sites with stress on six aspects: (1) page activity measured by the number of posts published, (2) page popularity measured by the number of likes, (3) citizens loyalty measured by the number of followers, (4) responsiveness measured by the number of users' reactions, (5) involvement measured by the number of comments, and (6) virality measured by the number of sharings. The research sample is represented by the official Facebook pages of 13 regions of the Czech Republic. The study findings showed high regional differences according to individual aspects of engagement as well as a total engagement of citizens.

**Keywords:** Social Media, Engagement, Public administration, Facebook, Regional Authorities, Content Analysis, Czech Republic.

## **1 Introduction**

Increased interest of citizens to participate in public sphere in hand with the advances of information and communication technologies (ICT) have created new challenges for innovative form of citizen and public sector relationship. Fung [4] in his article mentions that citizen participation supports three main aspects of governance: effectiveness, legitimacy, and social justice. An advent of ubiquitous use of ICT, and specifically social media (SM) bring new possibilities on the side of citizens as well as public involvement.

SM serves as a technology which facilitates the dissemination and sharing of information. SM tools are mainly represented by general platforms as Facebook, Instagram, Twitter, or YouTube, communication tools as Skype or SecondLife, or professional tools as LinkedIn or ResearchGate. These social network platforms are greatly useful to enhance mutual communication at the agency, community, and policy level.

## **2 Background and Conceptual Framework**

### **2.1 Current Research on Social Media Use in Public Sector**

Social media have commonly begun to be used in a various field of public administration. Prior studies have investigated use of social media, and specifically the Facebook, in the public sector particularly with a focus on information science [9, 11], public administration [14, 17], communication [10, 13] and public health [6]. Regarding the geographical location, the highest number of research studies in the field was conducted in the Western Europe and USA. However, very little research was done in the area of citizens' engagement by the Facebook sites [2, 16]. Moreover, no research studies in the field of engagement exist in Central and Eastern European countries.

### **2.2 Conceptual Framework and Propositions**

Various conceptual frameworks were designed to capture a people engagement on Facebook page related to the environment of business, nonprofit and public organizations [2, 6, 12]. In 2012, Jan H. Kietzmann et al. designed a honeycomb framework [12] to investigate facets of the social media from user experience. It deals with seven functional blocks of social media: identity, conversations, sharing, presence, relationships, reputation, and groups. Each block comprises (1) specific facet of social media user experience, and (2) its implication for firms. The framework is frequently used for description of Facebook and Youtube engagement. In 2013, Bonsón, Royo, and Ratkai [2] concentrated their research directly on citizen engagement and developed metrics as popularity, commitment, virality for the Facebook page engagement measurement. The framework of their approach to communication between government and citizens (G2C) and citizens to government (C2G) is illustrated in Fig. 1.

Despite of the great success of both previous studies, it should be stated that frameworks are, at least in some sense, a bit outdated, nowadays. Application of Kietzmann' framework is limited by his main orientation on business sector. Next, the challenge of Bonsón, Royo, and Ratkai' study lies in fact that it does not include facets of page credibility and reputation and is outdated in Facebook friends and followers understanding.

Resulting from the above, the research gap exists in both: formulation appropriate framework and metrics for measuring of citizens' engagement as well as to obtain a new knowledge about the level of citizens' engagement in Central and Eastern European countries. Therefore, the study objective is twofold, it aims on the development of a new set of metrics for measuring of citizens' engagement and the examination of current state of art in citizens' engagement on Facebook sites administered by regional governments located in the Czech Republic.

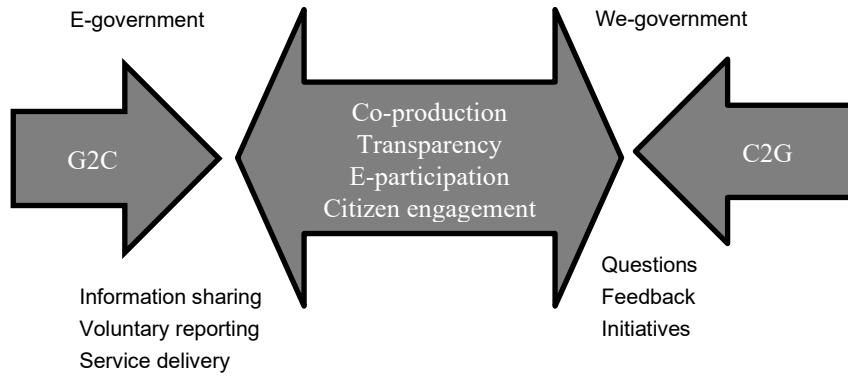


Fig. 1. The role of Facebook on G2C and C2G communication. [2]

### 3 Method and Research Sample

#### 3.1 Method

The study is based on the content analysis of Facebook pages. This kind of analysis conducted in online environment is a part of so-called Internet mediated research [7]. For the purpose of this study a new set of metrics to measure an engagement impact was set up. These metrics are partially based on the previous research of Bonsón where the metrics of activity, virality and popularity are formulated. However, the previous metrics were revised and extended.

Following metrics were formulated: activity, popularity, responsiveness, involvement, virality, evaluation, and loyalty; these metrics are summarized in Table 1. The first metrics - *Activity* - is expressed in number of posts published during a period set. The second metrics - *Popularity* - includes number of page likes. Although it may seem that this metrics clearly reflects the fans base of the site, its interpretation is not so distinct. As the page like is only a one-click activity, the user (citizen) doesn't have to see page posts anymore. The Facebook algorithm do not publish page posts into the feed of those who have liked the page. Moreover, likes can also be collected through marketing campaigns with incorrect targeting, which can bring fans with no interest of the page or the matters of the region. The third metrics - *responsiveness* (also called popularity in other studies) - can bring a better reflection of citizens' engagement than the previous two metrics as it is calculated as number of the reactions on a specific post. In 2016, the five new reactions as love, haha, wow, sad, and angry were introduced besides the original like. New responses on the post published enable us to better recognize the views and needs of the users, which play in important role in communication between citizens' and the regional government. Involvement is expressed by the number of comments. Writing a comment requires much higher participation, consideration and thinking of citizens than a simple one-click reaction. This kind of citizen participation can also contribute to solve issues common for the



public government and citizens. *Virality*, expressed through the number of posts shared, is a metrics with a high impact on the expansion of communication across the region. In this way, the communication can affect much broader auditorium than just page fans and/or followers base. Last two metrics are then devoted to evaluation and loyalty. Since *evaluation* is clearly expressed by the average score of reviewers, the loyalty is represented by the number of followers. *Loyalty* as a metrics can be considered as more important than popularity as in this case the citizens must to sign up to “follow” the matters on Facebook. All the followers (citizens) are then notified in their feeds about new posts, change of statuses and all other page actions.

**Table 1.** Metrics of citizen engagement on Facebook pages (APRIVEL).

Activity	A	Number of posts
Popularity	P	Number of page likes
Responsiveness	R	Number of posts reactions (Like, Love, Haha, Wow, Sad, Angry) /total posts
Involvement	I	Number of posts commented/total posts
Virality	V	Number of posts shared/number of posts
Evaluation	E	Score of reviews
Loyalty	L	Number of followers
Total engagement	E	$E = A+P+R+I+V+E+L$

### 3.2 Data

The data of analyzed facets were gathered during a seven-day period from Nov. 30, 2018 to Dec. 6, 2018. Data were processed in MS Excel and for the purpose of regional comparison (see Fig. 2) also transformed into standardized scores ranged from 0 to 10 pts. scale, where the maximum value for each metrics were taken as a basis for calculation.

### 3.3 Sample

Research study focuses on analysis of Facebook pages of Regions existing in the Czech Republic. According to the Act no. 129/2000 on Higher-level territorial self-governing units [1] is the Czech Republic divided into 13 regions and one capital city with regional status. The capitol Prague was excluded from the sample due to several highly different facts: much higher tourist attention, almost doubled GDP per capita (547,096 CZK), as well as significantly higher population (1,272,690 inhabitants) than in majority of regions. The main characteristics of the regions researched are summarized in Table 2.

**Table 2.** List of regions included in the sample. [5]

Name of the Region	Population <sup>1</sup>	Area (km <sup>2</sup> )	GDP per capita (CZK)
Central Bohemian	1,274,633	11,014.97	253,912

South Bohemian	637,460	10,056.79	251,106
Vysočina	512,727	6,795.56	234,530
Plzeň	574,694	7,560.93	216,639
Karlovy Vary	310,245	3,314.46	216,639
Ústí nad Labem	830,371	5,334.52	229,146
Liberec	439,262	3,162.93	229,146
Hradec Králové	555,683	4,758.54	244,549
Pardubice	505,285	4,519	230,880
Olomouc	639,946	5,266.57	211,467
Moravian-Silesian	1,236,028	5,426.83	222,638
South Moravian	1,169,788	7,194.56	254,684
Zlín	590,459	3,963.55	222,885

<sup>1</sup> Census of Czech Statistical Office, 2011

## 4 Analysis and Results

### 4.1 Activity

Publishing *activity* of page admins and editors in examined regions ranged from 2 to 40 posts during given 7 days. The most active were Liberec region with almost six posts published per day (5.7) and Central Bohemian with almost five posts (4.6). Contrariwise, the least active were South Bohemian and South Moravian region with one post per day (1.1), and mainly Ústí region with only 0.3 post per day.

### 4.2 Loyalty and Popularity

At first, the *loyalty*, as more significant metrics, is presented. The region with the highest number of loyal citizens is Moravian-Silesian region with 12,042 followers. Two other regions with a nearly ten thousand fan base follows: Hradec Králové (9,970 followers) region and Central Bohemian region (9,833 followers). On the other side of spectrum, there are two regions with less than three thousand followers: Olomouc (2,279 followers), and Zlín (1,529 followers) region. At second, the *popularity*, as an additional metrics, is presented. The most popular region regarding the number of page likes is Moravian-Silesian region with 11,802 likes. Next, there are two regions with a nearly ten thousand fan base: Hradec Králové (9,832 likes) region and Central Bohemian region (9,699 likes). On the other side of range, there are three regions with less than three thousand fans: Plzeň (2,813 likes), Olomouc (2,253 likes), and Zlín (1,460 likes) region. At third, the next additional metrics is an *evaluation*. Among the best regions are South Bohemian (5.0 review average score out of 5.0 maximum), Vysočina (4.9), Moravian-Silesian (4.8), and Hradec Králové (4.8) region. On the other hand, the regions as Karlovy Vary, Ústí, and South Moravian got only 4.1 or

respectively 4.0 pts. average score evaluation. Three regions – Central Bohemian, Pardubice, and Zlín regions – did not make a review option available for citizens.

**Table 3.** Responsiveness of Facebook pages of Regions.

Region	No. of followers	No. of page likes	Review score
Moravian-Silesian	12042	11802	4.8
Hradec Králové	9970	9832	4.8
Central Bohemian	9833	9699	n/a
Pardubice	8230	8171	n/a
Ústí	6847	6716	4.1
Liberec	6337	6236	4.7
Karlovy Vary	5447	5384	4.1
South Bohemian	4628	4524	5.0
Vysočina	4082	4041	4.9
South Moravian	3314	3211	4.0
Plzeň	3150	2813	4.5
Olomouc	2279	2253	4.2
Zlín	1529	1460	n/a

### 4.3 Responsiveness

More exact findings on citizens' engagement are provided through responsiveness metrics. Expressed in absolute value, the highest number of reactions got Karlovy Vary (125 reactions per day) and Liberec (108 reactions per day) region. Nevertheless, the ratio reactions / posts provide more interesting insights. For example, the South Bohemian region got 695 reactions on only 8 posts per week, while Liberec region got 756 reactions on their 40 posts. The relative responsive responsiveness than differentiate a lot from the absolute. Relatively, the most successful region is South Bohemian (87 reactions per post), following by South Moravian region (48 reactions per post). On the contrary, less than 10 reactions per posts were recorded in Zlín (8.5), Olomouc (5.9) and Central Bohemian (4.6) region. Results are provided in Table 4.

**Table 4.** Responsiveness of Facebook pages of Regions.

Region	No. of posts	No. of reactions	Reactions / posts
South Bohemian	8	695	86.9
South Moravian	8	382	47.8
Moravian-Silesian	12	423	35.3
Karlovy Vary	25	872	34.9
Hradec Králové	20	571	28.6

Ústí	2	56	28.0
Pardubice	11	251	22.8
Liberec	40	756	18.9
Vysočina	16	260	16.3
Plzeň	10	109	10.9
Zlín	15	128	8.5
Olomouc	16	94	5.9
Central Bohemian	32	146	4.6

#### 4.4 Involvement

The highest involvement of citizens in the region' agenda was recorded in Karlovy Vary region (2.7 comments per post) and South Bohemian region (2.38). Vice versa, in eight examined regions (62 % out of the sample) only 0.5 comments per post or lower was found. Results are summarized in Table 5.

**Table 5.** Involvement of citizens on a Facebook page.

Region	No. of posts	No. of comments	Comments / posts
Karlovy Vary	25	67	2.68
South Bohemian	8	19	2.38
Moravian-Silesian	12	19	1.58
Hradec Králové	20	24	1.20
Pardubice	11	12	1.09
South Moravian	8	4	0.50
Liberec	40	15	0.38
Central Bohemian	32	11	0.34
Vysočina	16	3	0.19
Olomouc	16	3	0.19
Zlín	15	2	0.13
Plzeň	10	1	0.10
Ústí	2	0	0.00

#### 4.5 Virality

Similarly to the previous metrics, there were also significant differences between regions in the case of virality. Viral communication was recorded especially in Karlovy Vary region, where one post was shared 34 times in average, and in South Bohemian region with 16 sharings per post. On the contrary, almost no virality was found in

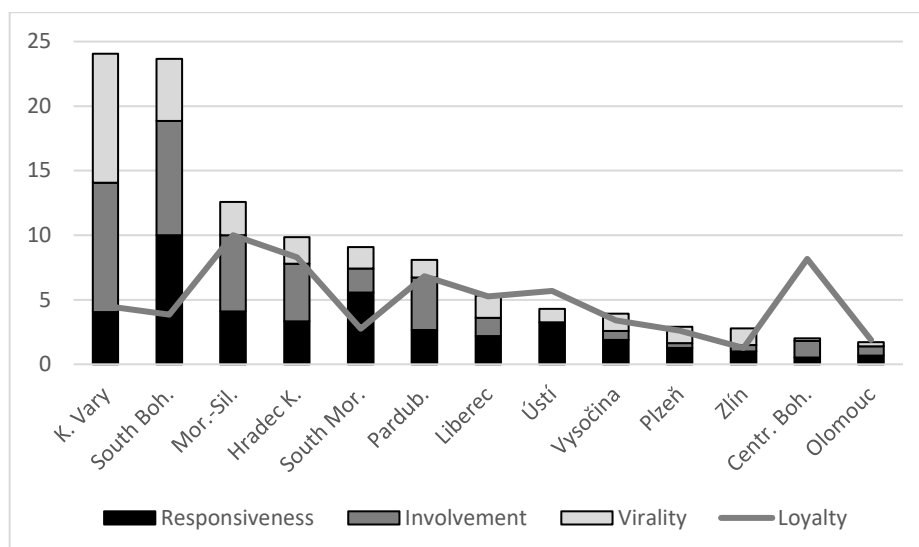
Olomouc and Central Bohemian region with 1.13, resp. 0.69 sharings per post. Detailed results are summarized in Table 6.

**Table 6.** Virality of posts published on a Facebook page of the Region.

Region	No. of posts	No. of shared posts	Sharings / posts
Karlovy Vary	25	851	34.04
South Bohemian	8	131	16.38
Moravian-Silesian	12	105	8.75
Hradec Králové	20	140	7.00
Liberec	40	238	5.95
South Moravian	8	45	5.63
Pardubice	11	51	4.64
Vysočina	16	72	4.50
Zlín	15	66	4.40
Plzeň	10	43	4.30
Ústí	2	7	3.50
Olomouc	16	18	1.13
Central Bohemian	32	22	0.69

## 5 Discussion and Conclusion

The study results can be interpreted from the three perspectives: (1) work of administrators and editors of the region' Facebook site, where the frequency of posts, quality of its content, used graphics, quality of multimedia and other factors should be taken into account; (2) the relationship built with citizens, which is presented by metrics such as popularity, loyalty and evaluation; and (3) citizens' engagement represented by metrics as responsiveness, involvement, and virality. Naturally, the citizens' engagement is made up of all these activities. The first activities are to establish a first communication with citizens; the second activities are then used to build a base of friends and followers and increase overall credibility of the page to deepen mutual citizen vs. government relationship; and finally, the third activities represents the relationship itself and as such reflect the real engagement of the citizens. For this reason, the last activities as an engagement output can be considered as the vital contribution of this study. The Figure 2 illustrates the main insights of the citizens' engagement for the Facebook sites of the regions examined.



**Fig. 2.** Citizens' engagement on regional governments Facebook pages.

Various implications for administration of public sector can be raised over the paper findings. We consider following implications as the most vital: (a) Significant differences among regions in citizens' engagement were found. It is related to the total engagement as well as to the engagement related to individual metrics. The differences exist mainly between activity, popularity, and virality of examined Facebook pages. (b) Activity represented by the number of posts per chosen time period is not associated with the level of citizens' engagement, in any way. For example, the regions with very high publishing activity as Liberec (40 posts per 7 days) and Central Bohemian (32 posts per 7 days) dispose of only medium or low level of responsiveness, involvement and virality. (c) The highest variances in citizens' engagement were recorded in virality metrics. The posts published by Karlovy Vary region were shared fifty times more frequently than posts published by Central Bohemian region. The study has brought several interesting insights into the field of citizens' engagement for regional administration. However, there are still many other opportunities for research and many more other metrics to examine in the context of social networks use in a public sector.

## References

1. Best, P, Manktelow, R., Taylor, B. J.: Social Work and Social Media: Online Help-Seeking and the Mental Well-Being of Adolescent Males. *The British Journal of Social Work* 46(1), 257–276 (2016). DOI: 10.1093/bjsw/bcu130.
2. Bonson, E., Royo, S., Ratkai, M.: Citizens' engagement on local governments' Facebook sites. An empirical analysis: The impact of different media and content types in Western Europe. *Government information quarterly* 32(1), 52-62 (2015). DOI: 10.1016/j.giq.2014.11.001.

3. Czech Republic. Act no. 129/2000 Coll. (Law on Regions) on higher-level territorial self-governing units, [https://ipfs.io/ipfs/QmXoypizjW3WknFiJnKLwHCnL72vedxjQkDDP1mXWo6uco/wiki/Regions\\_of\\_the\\_Czech\\_Republic.html](https://ipfs.io/ipfs/QmXoypizjW3WknFiJnKLwHCnL72vedxjQkDDP1mXWo6uco/wiki/Regions_of_the_Czech_Republic.html) , last accessed 2018/12/01.
4. Fung A.: Putting the Public Back into Governance: The Challenges of Citizen Participation and Its Future. *Public Administration Review* 75, 513-522 (2015). DOI: 10.1111/puar.12361.
5. Geohive. Census of Czech Statistical Office, 2011, <http://www.geohive.com/cntry/czech.aspx>, last accessed 2018/10/10.
6. Grajales, F.J., Sheps, S., Ho, K., Novak-Lauscher, H., Eysenbach, G.: Social Media: A review and tutorial of applications in medicine and health care. *Journal of medical internet research* 16(2), e13 (2014). DOI: 10.2196/jmir.2912.
7. Hewson, C.: Gathering data on the Internet. *Qualitative approaches and possibilities for mixed methods research. The Oxford Handbook of Internet Psychology*. Oxford University Press, UK (2007).
8. Househ, M.: The Use of Social Media in Healthcare: Organizational, Clinical, and Patient Perspectives. In: Courtney, K. L., Shabestari, O., Kuo, A. (eds.) *Enabling Health and Healthcare Through ICT: Available, Tailored and Closer*. p. 244 (2013).
9. Janowski, T.: Digital government evolution: From transformation to contextualization. *Government information quarterly* 32(3), 221-236 (2015). DOI: 10.1016/j.giq.2015.07.001.
10. Kennedy, H., Moss, G., Birchall, C., et al.: Balancing the potential and problems of digital methods through action research: methodological reflections. *Information communication & Society* 18(2), 172-186 (2015). DOI: 10.1080/1369118X.2014.946434.
11. Khan, G. F., Yoon, H.Y., Kim, J., Park, H.W.: From e-government to social government: Twitter use by Korea's central government. *Online information review* 38(1), 95-113 (2014). DOI: 10.1108/OIR-09-2012-0162.
12. Kietzmann J. H., Hermkens, K., McCarthy, I. P., Silvestre, B. S.: Social media? Get serious! Understanding the functional building blocks of social media. *Business Horizons* 54(3), 241-251 (2011). DOI: 10.1016/j.bushor.2011.01.005.
13. Lecheler, S., Kruikemeier, S.: Re-evaluating journalistic routines in a digital age: A review of research on the use of online sources. *New Media & Society* 18(1), 156-171 (2016). DOI: 10.1177/1461444815600412.
14. Ma, L.: Diffusion and assimilation of government microblogging. *Public management review* 16(2), 274-295 (2014). DOI: 10.1080/14719037.2012.725763.
15. McCarthy, J.: Blended learning environments: Using social networking sites to enhance the first year experience. *Australasian Journal of Educational Technology* 26(6), 729-740 (2010).
16. McNutt, K.: Public engagement in the Web 2.0 era: Social collaborative technologies in a public sector context. *Canadian public administration-Administration publique du Canada* 57(1), 49-70 (2014). DOI: 10.1111/capa.12058.
17. Song, C., Lee, J.: Citizens' use of social media in government, perceived transparency, and trust in government public. *Public performance & management review* 39(2), 430-453 (2015). DOI: 10.1080/15309576.2015.1108798.
18. Young, J.: The current status of social media use among nonprofit human service organizations: An exploratory study (Doctoral dissertation). Virginia Commonwealth University, Richmond, VA., <https://digarchive.library.vcu.edu/handle/10156/3775>, last accessed 2017/10/10.

## Sustainable Development in the Polish-Czech Cross Border Area - Indicators Analysis

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**Abstract.** The European Grouping of Territorial Cooperation NOVUM (EGTC NOVUM) was established in 2015 and conducts its activities in the Polish-Czech borderland. The main aim of NOVUM is to intensify, facilitate and promote Polish-Czech cross-border cooperation aimed at the strengthening of economic and social cohesion of the area of operation of the Grouping. Sustainable development is a widely accepted concept of development. Currently, striving for sustainable development is one of the biggest challenges. This concept is implemented at various levels of development from international, through national, regional to local. The article attempts to determine the degree of implementation of sustainable development in the area of operation of EGTC NOVUM. Indicators describing the social, economic and environmental situation have been chosen in order to achieve this objective. The analysis was carried out for the years 2014-2016. Among the indicators selected for analysis were, inter alia: gross domestic product per capita, expenditure on R&D, employment rate, unemployment rate, gross fertility rate, protected area.

**Keywords:** EGTC NOVUM, Sustainable Development, Indicators.

### 1 Introduction

The European Union has created the European grouping of territorial cooperation (EGTC) as a legal instrument to facilitate cross-border cooperation. EGTCs conduct their activities based on Regulation (EC) No 1082/2006 of the European Parliament and of the Council of 5 July 2006 on a European grouping of territorial cooperation (EGTC) [19], which allows for the creation of cooperation units by public entities from different Member States. In addition, it provides these entities with a Community legal framework. Thus, it can be generally written that European groupings of territorial cooperation are legal entities created by Member States, local and regional authorities and other entities governed by public law. Such an entity is of course created on the territory of the European Union and allows for the establishment of formal cooperation groups by public entities from different Member States.

It should be noted that the first EGTC, Eurométropole Lille-Kortrijk-Tournai, was created in January 2008. It enables cooperation between significantly different authorities from three different administrative levels in Belgium and France. The



official headquarters are in France and the French authorities have accepted the EC Regulation as a basic right, allowing them to employ staff in accordance with Belgian law [14].

The European Grouping of Territorial Cooperation NOVUM (EGTC NOVUM) was established in 2015. The Convention and Statute of the Grouping were signed in September of that year, while its legal personality was established in December. NOVUM operates in the Polish-Czech borderland. Its founders and members are institutions from the Czech Republic and Poland. There are five regional authorities: one from Poland – Dolnośląskie Voivodship (Region) and four from Czech Republic (Hradec Králové Region, Liberec Region, Olomouc Region and Pardubice Region), as well as two Polish-Czech Euroregions: Nysa and Glacensis. NOVUM was established in order to intensify, facilitate and promote Polish-Czech cross-border cooperation aimed at the strengthening of economic and social cohesion of the area of operation of the Grouping. NOVUM conducts its activities based on the Strategy of integrated cooperation of the Czech-Polish border 2014-2020. The main areas of activities are: economic cooperation, transport, environmental protection, health protection, spatial planning and administrative problems.

The literature emphasizes that the creation of EGTC NOVUM increases the economic attractiveness of the Polish-Czech borderland area and that this grouping, as a new subject of European Union law, advances the Polish-Czech cross-border cooperation in the implementation of the European Union's regional policy [1]. It is also pointed out that the Polish-Czech borderland has become a model example of the most innovative cross-border cooperation. The first Euroregions in Poland were created here, followed by the European Grouping of Territorial Cooperation (EGTC). For example, December 2016 marked the twentieth anniversary of the Polish-Czech Euroregion Glacensis. However, there is still untapped potential. Overcoming difficulties in contacts and effective implementation of new forms of cooperation may increase the chances for development of this region [17].

Sustainable development is a widely accepted concept of development. Currently, striving for sustainable development is one of the biggest challenges. This concept is implemented at various levels of development from international, through national, regional to local. Sustainable development is a concept that integrates various aspects. Research concerning the implementation of sustainable development takes into account the social, economic, environmental and institutional dimensions. The monitoring of this development concept is carried out using indicators that describe each of the areas included in sustainable development. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In its essence, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations [20]. The subject literature lists three basic qualities of sustainable development, i.e. sustainability, durability and self-sustenance. T. Borys indicates that the concept of sustainable development refers to a process of changes which is characterized by an attribute of sustainability evaluated positively from the point of view of at least anthropocentric

system of values or – briefly, though less precisely – to development which has an attribute of sustainability [3, 11, 12]. At this point, it should be emphasized that despite many years of research and discussions, this concept has not received any clear and uniform definition. As a partial explanation of the emerging differences, one can point to an extensive and complex number of elements included in the concept of sustainable development. One of the most frequent inaccuracies and simplifications is reducing sustainable development to environmental or ecological aspects [16, 12].

The article attempts to determine the degree of implementation of sustainable development in the EGTC NOVUM area. In order to achieve this objective, indicators describing the social, economic and economic situation have been selected from generally available statistical sources for Dolnośląskie Voivodship, Hradec Králové Region, Liberec Region, Olomouc Region and Pardubice Region. The analysis was carried out in the years 2014-2016. Among the indicators selected for analysis were, inter alia: gross domestic product per capita, expenditure on R&D, employment rate, unemployment rate, gross fertility rate, protected areas. The analysis will show how the concept of sustainable development is implemented in the area of EGTC NOVUM. The spatial diversity of individual indicators and their changes in the analyzed period will be shown.

## 2 Research Methodology, Sustainable Development Indicators

Indicators represent quantity specific tools which synthesize or simplify the data crucial for the assessment of certain phenomena. These tools are useful in communicating, assessing and making decisions [13]. Indicators are the basic instruments used in the monitoring of sustainable development, since they present such a concept of development in a rational and measurable way [3]. Sustainable development indicators can be defined as a statistical measure that gives an indication on the sustainability of social, environmental and economic development [9].

The indicators used for the purposes of the conducted analyses allow for the analysis of progress in the implementation of sustainable development in the selected territorial units (regional level in this case), in accordance with the European Union's approach to the measurement of sustainable development. Sustainable development is a diverse phenomenon that integrates the economic, environmental and social dimensions. In order to conduct an analysis regarding the implementation of sustainable development, one should select the indicators describing each of these areas. The list of the selected indicators is presented in tab. 1.

**Table 1.** Sustainable development indicators chosen for EGTC NOVUM area.

No.	Indicator
1.	GDP per capita (EUR)
2.	General unemployment rate (%)

3. Infant mortality rate
4. Population ages 65 and above (% of total)
5. Life expectancy at birth, Males
6. Life expectancy at birth, Females
7. Percentage of households with Internet access
8. Physicians per 1,000 population
9. Registered criminal offences per 1,000 population
10. Municipal waste per capita (kg)
11. Share of population supplied with water from public water supply systems (%)
12. Share of population living in houses connected to public sewerage systems (%)

For each of these indicators, data for the years 2014-2016 were collected and subsequently analyzed. This made it possible to show the basic values characterizing the phenomenon of sustainable development in the EGTC NOVUM area. This is the first analysis for this area. The main difficulty was the selection of indicators for which comparable data would be available. The ability to present indicators at the regional level is always very limited due to the availability of data. However, it is very important to conduct this analysis. The establishment of EGTC NOVUM resulted in the creation of a joint cross-border Polish-Czech region of approximately 37.7 thousand km<sup>2</sup>, which is inhabited by over 5 million people (Table 2).

**Table 2.** Population and area of EUWT NOVUM [4, 5, 6, 7, 8].

Region	Population (persons)	Area (km <sup>2</sup> )
Dolnośląskie	2 930 710	19 947
Hradec Králové	550 804	4 759
Liberec	440 636	3 163
Olomouc	517 087	4 519
Pardubice	633 698	5 271
Total	5 072 935	37 659

Out of all of the inhabitants of the EGTC NOVUM area, 58% live in Poland, and 42% in the Czech Republic. The area on the Polish side constitutes almost 53% of the entire NOVUM area. Therefore, the EGTC forms an area of cooperation split roughly in half between the two countries, both in terms of population and area. Before the creation of NOVUM, the "large" Polish voivodship was cooperating with the relatively "small" Czech regions.

### 3 Results

The analysis included selected indicators for which comparable data for all regions could be obtained. The values of individual indicators in 2014-2016 are presented in tab. 3.

**Table 3.** Sustainable development indicators in the EGTC NOVUM members in the years 2014-2016 [4, 5, 6, 7, 8].

Region	2014	2015	2016
GDP per capita EUR			
Dolnośląskie	11,954	12,477	12,290
Hradec Králové	13,043	13,858	14,835
Liberec	11,539	12,356	13,032
Olomouc	11,571	12,271	12,828
Pardubice	12,097	12,993	13,330
General unemployment rate (%)			
Dolnośląskie	10,4	8,5	7,2
Hradec Králové	6,2	5,6	4,1
Liberec	6,5	5,5	4,4
Olomouc	7,7	5,9	3,7
Pardubice	6,4	4,6	3,7
Infant mortality rate			
Dolnośląskie	4,6	3,8	3,8
Hradec Králové	2,4	1,8	3,2
Liberec	2,5	2,1	2,6
Olomouc	4,5	2,9	2,5
Pardubice	2,2	1,9	1,8
Population ages 65 and above (% of total)			
Dolnośląskie	15,52	16,2	17
Hradec Králové	19	19,6	20,2
Liberec	17,6	18,3	18,9
Olomouc	18,2	18,7	19,3
Pardubice	18	18,5	19
Life expectancy at birth, Males			
Dolnośląskie	73,1	73,2	73,5
Hradec Králové	76,19	76,64	76,96
Liberec	75,09	75,67	76,15
Olomouc	74,5	74,95	74,43
Pardubice	76,08	76,35	76,41
Life expectancy at birth, Females			
Dolnośląskie	81,1	81	81,4
Hradec Králové	81,84	81,89	82,23
Liberec	81,47	81,45	81,82
Olomouc	81,38	81,02	81,55

Pardubice	81,61	82,06	82,38
Percentage of households with Internet access			
Dolnośląskie	68,4	72,2	72,9
Hradec Králové	71,5	73,8	75,4
Liberec	69,1	71,2	72,9
Olomouc	62,2	65,2	67,3
Pardubice	71,3	73,3	75
Physicians per 1,000 population			
Dolnośląskie	2,2	2,3	2,3
Hradec Králové	4,7	4,5	4,6
Liberec	3,9	4,0	3,9
Olomouc	4,8	4,8	4,8
Pardubice	4,1	3,9	4,0
Registered criminal offences per 1,000 population			
Dolnośląskie	21,1	20,0	19
Hradec Králové	18,5	15,6	13,2
Liberec	28,8	25,4	20,9
Olomouc	22,1	19,9	18,3
Pardubice	16,2	13,2	11,5
Municipal waste per capita (kg/per year)			
Dolnośląskie	324	340	361
Hradec Králové	272	295	304
Liberec	272	295	304
Olomouc	312	330	350
Pardubice	303	315	332
Share of population supplied with water from public water supply systems (%)			
Dolnośląskie	94,8	94,9	94,9
Hradec Králové	93,8	94,4	94,9
Liberec	91,8	92,7	92,7
Olomouc	90,5	91,4	91,8
Pardubice	97,3	97,6	97,5
Share of population living in houses connected to public sewerage systems (%)			
Dolnośląskie	75	75,7	76,3
Hradec Králové	77,1	78,1	78,5
Liberec	68,5	68,9	69
Olomouc	80,5	82,4	82,9
Pardubice	72,8	73,7	74,4

In each of the analyzed years, the Hradec Králové region had the highest GDP per capita. The lowest value in 2014 was recorded in the Liberec region, in the following year in Olomouc and in 2016 in Dolnośląskie. It should also be emphasized that the regions are slightly diversified in terms of this indicator. The coefficient of variation was 4,5% in 2014, 4,6% in 2015 and 6,5% in 2016.

The highest unemployment rate throughout the analyzed period occurred in Dolnośląskie. The lowest rate in 2014 was recorded in the Hradec Králové region, in 2015 in the Pardubice region, and in 2016 in the Olomouc and Pardubice regions. The regions are little different in terms of unemployment rate, but this variation is increasing. The coefficient of variation was 15,1% in 2014, 15,5% in 2015 and 18,3% in 2016.

The lowest infant mortality rate in 2014 and 2016 occurred in the Pardubice region, and in 2015 in the Hradec Králové region. The worst situation in each of the analyzed years was in Dolnośląskie. It is also worth emphasizing that the regions are moderately different in terms of this index and this diversification is diminishing each year. The coefficient of variation was 33,2% in 2014, 30,0% in 2015 and 24,3% in 2016.

The lowest share of population aged 65 and above (% of total) in each of the analyzed years occurred in Dolnośląskie, while the highest share was recorded in Hradec Králové. The regions are slightly different in terms of this indicator and the variation is getting smaller each year. The coefficient of variation was 6,6% in 2014, 6,1% in 2015 and 5,5% in 2016.

The shortest life expectancy at birth, both for women and men, occurred in the Dolnośląskie voivodship in each of the analyzed years. Life expectancy for men was the longest in the Hradec Králové region each year. For women, it was the longest in Hradec Králové in 2014 and in the Pardubice region in subsequent years. The regions show virtually no differentiation in terms of these indicators

The next indicator analyzed was the percentage of households with Internet access. The research conducted shows that this share has been increasing in each of the regions from year to year. The minimum value in each of the analyzed years was recorded in the Olomouc region, and the maximum in the Hradec Králové region. The coefficient of variation was 4,9% in 2014, 4,4% in 2015 and 4,0% in 2016.

The lowest number of physicians per 1,000 population in each of the years was recorded in Dolnośląskie region, and the highest in Olomouc region. It is worth noting that in the Czech regions the value of this indicator is almost twice as high as in the Polish region. Diversity in each of the analyzed years was on the average level. The coefficient of variation was 23,7% in 2014, 22,2% in 2015 and 22,4% in 2016.

The highest rate of registered criminal offenses per 1,000 population in each of the analyzed years occurred in the Liberec region and the lowest in the Pardubice region. A positive phenomenon is the diminishing value of this indicator for the period. The coefficient of variation was 20,0% in 2014, 22,3% in 2015 and 21,7% in 2016.

The largest amount of municipal waste per capita (kg) in each of the surveyed years was produced in the Dolnośląskie Voivodship, and the least in the Hradec Králové region. An unfavorable phenomenon is the year-by-year increase in the amount of waste generated. The coefficient of variation was 7,1% in 2014, 5,8% in 2015 and 7,1% in 2016.

The percentage of water supply systems (%) in the surveyed regions is at a high level exceeding 90%. The lowest was recorded in the Olomouc region, and the highest in the Pardubice region. The coefficient of variation was 2,5% in 2014, 2,2% in 2015 and 2,1% in 2016.

The share of population living in houses connected to public sewerage systems (%) was on a lower level. The highest value was recorded in the Olomouc region and the lowest in Liberec. The coefficient of variation was 5,4% in 2014, 5,9% in 2015 and 6,0% in 2016.

## **4 Results and Discussion**

EGTC NOVUM is a grouping that has been functioning for less than 3 years. Its activity focuses on building partnerships between entities in the area of its operation. Nevertheless, sustainable development of the entire area seems to be an important issue. The attempt to analyze the implementation of the concept of sustainable development based on selected indicators showed some very important issues. First of all, the Czech and Polish regions are very similar to each other in terms of the majority of indexed indicators. Differentiation at a noticeable level can be noted in relation to the following indices: Infant mortality rate, physicians per 1,000 population and registered criminal offenses per 1,000 population. Another very important conclusion that can be formulated is the fact that positive changes can be observed for all indicators except municipal waste per capita. In the case of the stimulant, the value of the indicators increases, and in the case of the destimulant decreases. The analysed regions are very similar to each other. The creation of EGTC NOVUM will, however, contribute to strengthening the cooperation between them. It will be possible to implement common projects, which in turn may contribute to a more complete implementation of the idea of sustainable development. The projects currently being implemented concern all areas of sustainable development. There are projects concerning cooperation in the fields of economy and environmental protection, as well as social aspects. The effects of these projects will be visible in a few years. After this time, it will be also possible to estimate the impact of NOVUM on the implementation of the idea of sustainable development in the Czech-Polish borderland.

## **5 Conclusions**

In conclusion, it should be stated that EGTC NOVUM is an important instrument of cross-border cooperation between Poland and the Czech Republic. Its activity has a significant impact on strengthening cooperation between entities in the area of its operation. This attempt at an analysis was the first to concern the scope of implementation of the concept of sustainable development. It was carried out based on available indicators for which comparable data could be obtained. This analysis has shown that it is necessary to carry out comprehensive quantitative research to determine the progress in implementing this development concept. The analysis also showed a very close resemblance between the Czech and Polish regions. It can therefore be pointed out that this area shows little diversity and that the regions are very similar in many aspects.

## 6 References

1. Adamczuk, F.: Uwarunkowania powstania Europejskiego Ugrupowania Współpracy Terytorialnej NOVUM (EUWT NOVUM) na pograniczu polsko-czeskim. *Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania Uniwersytetu Szczecińskiego* nr 40. T. 1, 101-110 (2016).
2. Borys, T.: (ed.), *Wskaźniki ekorozwoju*, Wydawnictwo Ekonomia i Środowisko, Białystok (1999).
3. Borys, T.: *Indicators for sustainable development – polish experiences*. Ekonomia i Środowisko, Warszawa-Białystok (2005).
4. CZSO, Regional Office Hradec Králové: *Statistical yearbook of the Královéhradecký region, Regional statistics*, Hradec Králové (2017).
5. CZSO, Regional Office Liberec: *Statistical yearbook of the Liberecký region, Regional statistics*, Liberec (2017).
6. CZSO, Regional Office Olomouc: *Statistical yearbook of the Olomoucký region, Regional statistics*, Olomouc (2017).
7. CZSO, Regional Office Pardubice: *Statistical yearbook of the Pardubický region, Regional statistics*, Pardubice (2017).
8. Euroregion Glacensis: *Analiza problemów systemowych współpracy transgranicznej na czesko-polskiej granicy*, [http://euroregions.org/files/documents/Analiza/ANALIZA\\_PROBLEMOW\\_ver\\_PL30092\\_014\\_final.pdf](http://euroregions.org/files/documents/Analiza/ANALIZA_PROBLEMOW_ver_PL30092_014_final.pdf), last accessed 2018/10/21.
9. EUWT NOVUM: *Konwencja o utworzeniu Europejskiego Ugrupowania Współpracy Terytorialnej NOVUM z ograniczoną odpowiedzialnością*, [www.euwt-novum.eu](http://www.euwt-novum.eu), last accessed 2018/10/21.
10. EUWT NOVUM: *Statut Europejskiego Ugrupowania Współpracy Terytorialnej NOVUM z ograniczoną odpowiedzialnością*, [www.euwt-novum.eu](http://www.euwt-novum.eu) (2015), last accessed 2018/10/21.
11. Faucheux, S., O'connor, M., Straaten, J.: *Sustainable Development: Concepts, Rationalities and Strategies*, Springer Science & Business Media, New York (1998).
12. Geniaux, G., Bellon, S., Deverre, C., Powell, B.: *Sustainable Development Indicator Frameworks and Initiatives, System for Environmental and Agricultural Modelling, Linking European Science and Society*, Report no. 49, SEAMLESS integrated project, EU 6th Framework Programme (2009).
13. *Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003*, United Nations, European Commission, International Monetary Fund, Organisation for Economic Cooperation and Development, World Bank, Studies in Methods, Series F, no 61, rev.1, New York 2003.
14. Mędza, A.: Europejskie ugrupowania współpracy terytorialnej w Polsce – wstępna ocena, In: E. Sobczak, D. Głuszczyk, M. Obrębalski (eds.), *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu* nr 392 *Gospodarka regionalna w teorii i praktyce*, Wrocław, 62-72 (2015).
15. Michałowski, A.: Ecosystem services in the light of a sustainable knowledge-based economy, in: *Problems of sustainable development*, vol. 7, no 2, p. 97-106 (2012).
16. Pawłowski, A.: *Sustainable Development as a Civilizational Revolution: A Multidisciplinary Approach to the Challenges of the 21st Century*, CRC Press, Taylor & Francis Group, London (2011).
17. Skorupska, A.: *Współpraca samorządowa na pograniczu polsko-czeskim*, Policy Paper, nr 17 (100), 1-8 (2014).
18. Statistical Office in Wrocław: *Statistical yearbook Dolnośląskie Voivodship*, (2017).



19. The European Parliament and of the Council: Regulation (EC) no 1082/2006 of the European Parliament and of the council of 5 July 2006 on a European grouping of territorial cooperation (EGTC). Official Journal of the European Union. L 219/19.
20. The World Commission on Environment and Development: Our common future, Oxford University Press, Oxford (1987).
21. UMWD: Strategia zintegrowanej współpracy polsko-czeskiego pogranicza (2014), [http://www.umwd.dolnyslask.pl/fileadmin/user\\_upload/EWT/Czechy/Plan\\_dzialania\\_do\\_I\\_aterreg/Strategia\\_zintegrowanej\\_wspolpracy\\_czesko-polskiego\\_pogranicza.pdf](http://www.umwd.dolnyslask.pl/fileadmin/user_upload/EWT/Czechy/Plan_dzialania_do_I_aterreg/Strategia_zintegrowanej_wspolpracy_czesko-polskiego_pogranicza.pdf), last accessed 2018/10/21.

# Commonality in Liquidity Measures. The evidence from the Polish Stock Market

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**Abstract.** The purpose of the paper is to examine commonality in liquidity across stocks listed on the Warsaw Stock Exchange. Commonality refers to the common behavior of the liquidity measures across different stocks. We consider liquidity proxies based on widely available low-frequency data, as well as spreads calculated from the transaction data. Our sample consists of stocks listed constantly from 2006 through 2016. We find that commonality in liquidity is weak and robust to the choice of liquidity proxy. Large companies show more commonality than the smaller ones. Commonality is time-varying: it increases as liquidity dries up.

**Keywords:** High-low Range, Effective Spread, Illiquidity.

## 1 Introduction

Liquidity is one of the most important issues considered in the contemporary finance. The evolution of liquidity is of concern in many papers [1, 2, 16] as are the reasons for common movement in liquidity measures within a given market [3, 11, 14, 18] and among different stock markets [12, 13].

As liquidity itself is a latent variable, it is generally accepted in the literature that different proxies are used. Within the literature devoted to the stock markets, a vast number of papers is dedicated to the choice of the best liquidity measure [7, 8]. Another strand of the literature focuses on the issue to what extent are these, better or worse, measures correlated [15]. This is often called the commonality in liquidity and defined simply as the covariation between different liquidity measures. Thus commonality is the market-wide co-movement in various liquidity measures that determines the systematic liquidity risk. The seminal paper on the commonality is written by Chordia, Roll and Subrahmanyam in 2000 [4]. They point the important issue whether shocks in trading costs constitute a source of non-diversifiable priced risk. As the risk is connected with illiquidity (the lack of liquidity) we may put it in other words: is there an additional systemic risk that comes from the commonality in liquidity? Implications for commonality are twofold [4]: first, in the static approach it explains the differences in trading costs among stocks within a single time period, and second, in the dynamic one, it is connected with liquidity risk for the portfolio within the given period.

Several theories on the origin of commonality in liquidity have been proposed. Surveys such as that conducted by Coughenour and Saad [6] on U.S. market show that commonality in liquidity comes from the fact that stocks share common market makers. On the contrary Naik and Yadaw [17] indicate that within the decentralized trading market makers focus on the liquidity risk position of the assets in portfolios managed by them and not by other dealers. Such approaches, however, have failed to address the situation in the order-driven markets, that operate without market makers (and this is the system used by several major stock exchanges in Europe, including the Warsaw Stock Exchange). Moreover, on the U.S. market Chordia, Roll, and Subrahmanyam [4] find the evidence in favor of commonality in liquidity, but the level of market-wide movement is rather low. It could be caused by the chosen liquidity proxy as well as time-varying feature of commonality, that depends on the specific market conditions. Hameed, Kang, and Viswanathan [10] find evidence that commonality in liquidity increases during periods of market downturns causing a spiral effect.

This study aims to contribute to this growing area of research by exploring the commonality issue on the emerging order driven market and considering few liquidity proxies, both in the static and the dynamic approach. In short, we examine if there exists the commonality in liquidity measures. The extensive research has been carried out already by Karolyi et al. [12], with the data from 44 stock exchanges, but we focus on one market only and get into the issue more deeply. We consider a portfolio consisting of big stocks listed constantly on the Warsaw Stock Exchange within the period of 11 years. Liquidity measures are calculated on the basis of widely available daily data. The importance and originality of this study are that it explores not only the level of commonality, but also examines if there are differences between commonality for various liquidity measures. It takes into account the size of the firms and looks for the reasons of commonality changes. Our findings can be summarized as follows: the commonality in liquidity proxies is weaker than reported in the previous studies [12] and weaker than on the developed markets [5, 9]. Commonality on the Polish capital market is time-varying and increases during global market turbulences as the global financial crisis, the European sovereign debt crisis and the Chinese debt crisis. We further find significant differences in commonality with respect to the size of the company: big firms show higher level of commonality than small firms. This result is robust to the choice of the liquidity proxy.

The rest of the paper has been divided into four parts. Section 2 presents the data, Section 3 introduces methodology and explains the liquidity proxies calculations as well as the commonality regressions structure. Section 4 is devoted to the empirical results, while last Section concludes.

## 2 Data

We use the data on 44 stocks that have belonged to WIG20 or WIG30 blue chip index listed on the Warsaw Stock Exchange (Poland). This exchange operates as an open limit order book market without market maker. The trades are made within a

continuous double auction mechanism where orders are matched with the price and time priority. Our stocks have been listed constantly from 2006 till 2016 and are considered as big stocks with capitalization over 250mln euro at the end of 2016. The sample period consists of 2754 days observed in 132 months. The data are from [www.stooq.pl](http://www.stooq.pl) database and includes four prices and volumes. We apply the usual filtering methods within the dataset [19]. We also use spreads calculated on the basis of high-frequency tick-by-tick data. This dataset comes directly from the WSE.

For each stock in the sample we calculate the average turnover as a product of daily close price and volume traded. Then we form a portfolio from stocks and calculate on a daily basis the weights of each stock as a proportion of stock turnover to the turnover of the whole portfolio (index weights). Although all these stocks were considered by the exchange as big ones at the end of 2016, there are substantial differences between the stocks included in this study, both in the aspect of their free float and turnover. We have five stocks with relatively high weights over 8% and twenty-one small stocks with weights lower than 0.5%. Thus the stocks represent the very diverse set.

### 3 Methodology

In absence of a commonly accepted liquidity index we propose two measures of market liquidity. We form two portfolios including stocks from our sample: first encompasses stocks with equal weights, and second uses the dynamic weights changing every day on the basis of the daily turnover of index constituents. Then we run commonality regressions for each stock and each market liquidity index.

We set few hypotheses: first, there is the commonality between single stock liquidity and the market liquidity (liquidity index), although it is weaker than shown in the previous studies [12]. Second, we expect there should be no significant differences between commonality coefficients for different liquidity proxies. Each proxy expresses different liquidity features, but in general there should be a consensus on the issue if market move together or not. Third hypothesis is that commonality is not stable over time. The last states that commonality differ between big and small stocks.

#### 3.1 Liquidity Measures Used in the Study

We calculate several liquidity measures for each stock in our sample. The common feature of these measures is that all are based on the daily data (four prices and volumes) and are calculated in daily frequency. Thus we consider illiquidity measure of Amihud (2002):

$$ILLIQ_t = |r_t| / [\log(volume_t)] \quad (1)$$

where  $r_t$  is a percentage logarithmic return, and  $volume_t$  is a product of the number of stocks traded within the day and the closing prices,  $volume_t = vol_t * C_t$ . We consider logs of volumes to reduce the impact of outlier observations. Next measure is Volatility over Volume,  $VoV_t$ :

$$VoV_t = \frac{\log\left(\frac{H_t}{L_t}\right)^{0.6}}{volume_{it}^{0.25}} \quad (2)$$

where  $H_t$  is the highest, and  $L_t$  is the lowest price observed within a given day  $t$ , while  $volume_t$  is rescaled in order to smooth the series [7]. Next measure is based on the range, that is the difference between the high and the low prices, and is scaled by mid-price:

$$HLR_t = \frac{H_t - L_t}{0.5(H_t + L_t)} \quad (3)$$

We also use the high-low spread estimator of Corwin and Schultz (2012):

$$S_t = \frac{2(e^\alpha - 1)}{1 + e^\alpha}, \quad (4)$$

where  $\alpha = \frac{\sqrt{2\beta} - \sqrt{\beta}}{3 - 2\sqrt{2}} - \sqrt{\frac{\gamma}{3 - 2\sqrt{2}}}$ ,  $\beta = \left[\ln\left(\frac{H_t}{L_t}\right)\right]^2 + \left[\ln\left(\frac{H_{t+1}}{L_{t+1}}\right)\right]^2$ ,

and  $\gamma = [\ln((\max\{H_t, H_{t+1}\})/(\min\{L_t, L_{t+1}\}))]$ .

In fact these three measures show illiquidity, so the higher are the values of proxies, the lower liquidity is provided on a given day. We also include one proxy,  $LIX_t$  measure, with opposite approach [7]:

$$LIX_t = \log_{10} \frac{volume_t}{H_t - L_t}. \quad (5)$$

We also include liquidity proxy that is calculated as the spread based on the tick-by-tick data with following the formula:

$$BAS_t = \frac{\sum_{k=1}^{N_k} vol_k(p_k^A - p_k^B)/p_k * c}{vol_t} \quad (6)$$

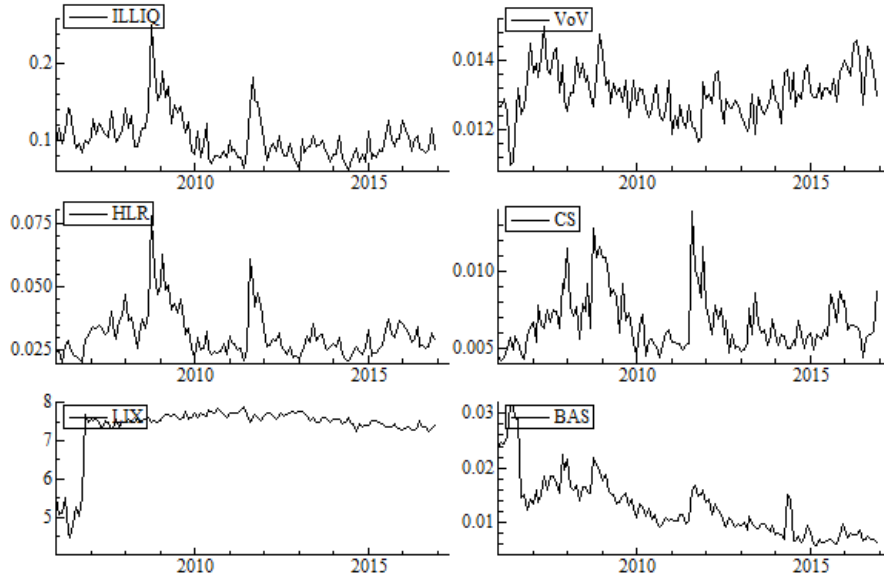
where  $p_k^A$  is an ask price of a given trade  $k$ ,  $p_k^B$  is a bid price, and  $p_k$  is a price of transaction  $k$ ,  $c$  is a constant equal to 2000,  $vol_k$  is a number of shares traded with a given price  $p_k$ ,  $N_k$  is a number of all transactions within a day  $t$  and  $vol_t$  is the overall volume within given day.

We calculate all liquidity proxies for every stock included in the sample. Table 1 presents summary of cross-sectional statistics for the time series of these liquidity measures. There is right skewness in the cross-section of average liquidity measures, namely *ILLIQ*, *HLR*, *CS*, *VoV* and *BAS*, as the sample means exceed sample medians. *LIX* behaves in the opposite way due to its reverse approach (the higher the value, the more liquidity is observed). The differences between single liquidity measures are not surprising as they take into account different features of liquidity.

On the basis of the stocks proxies, the market liquidity indices are calculated. Figure 1 presents the dynamics of liquidity indices – for more transparent presentation they are aggregated into monthly values. They are some similarities between them: *ILLIQ*, *VoV*, *HLR* and *CS* show the strong decrease in liquidity during financial crisis in 2008 and sovereign debt crisis in 2011. *LIX* shows a strong increase in liquidity in 2006, while spreads calculated on intraday data (*BAS*) increase strongly in the beginning of 2006 and then decrease gradually showing similar variations as the first four measures.

**Table 1.** Descriptive statistics for the liquidity measures

Proxy:	mean	sd	25%	50%	75%
ILLIQ	0.1148	0.1267	0.0297	0.0794	0.1579
HLR	0.0292	0.0216	0.0155	0.0246	0.0374
CS	0.0069	0.0099	0.0000	0.0025	0.0110
VoV	0.0404	0.0332	0.0193	0.0306	0.0518
LIX	5.9314	1.6254	5.0458	6.1226	7.0753
BAS	0.0038	0.0042	0.0012	0.0024	0.0049

**Fig. 1.** The dynamics of aggregated liquidity indices.

### 3.2 Commonality regressions

Following Hameed, Kang, and Viswanathan [10] and Karolyi et al. [12] we use determination coefficient,  $R^2$ , of the regression of an individual stock on the market liquidity index. In our study we run regressions for each liquidity measure for every stock and our two liquidity indices. As the liquidity measures and the indices are non-stationary, we apply the regressions for the first differences of the series. These differentiated series are featured by strong autocorrelation of order 1, so we use filtering regressions both for differences in liquidity measures and for differences in market index in a following form:

$$\Delta LiqVar_{it} = \varphi_0 + \varphi_1 \Delta LiqVar_{i(t-1)} + \varepsilon_{it} \quad (7)$$

where  $LiqVar_{it}$  is a liquidity variable for a stock or an index on day  $t$ ,  $\varphi_0$  is a constant,  $\varphi_1$  is a coefficient and  $\varepsilon_{it}$  is assumed to be distributed normally IID. We also considered the filtering out of day-of-the week effect, but no such an effect existed. Finally in the commonality regressions we use the innovations  $\varepsilon_{it}$  from AR(1) models. As in Karolyi et al. [12] for the commonality regressions for each stock  $j$  we separately calculate market liquidity index out of innovations  $\varepsilon_{it}$  and exclude this stock in index computation. This exclusion is important specifically in case of stocks with relatively high weights in the portfolio. Finally, we estimate the commonality regression in the following form:

$$\varepsilon_{it} = \beta_0 + \beta_1 * \varepsilon_{Mt} + \vartheta_{it} \quad (8)$$

where  $\varepsilon_{it}$  is the innovation for each stock (Eq.1),  $\varepsilon_{Mt}$  is obtained as a simple average or the market-value weighted-average of the innovations for the liquidity index and  $\vartheta_{it}$  is assumed to be normally distributed IID.

## 4 Empirical results

The empirical part consists of three sections: the first one is devoted to the daily regressions for stocks, the second examines coherence of the aggregated measures, while the last one studies monthly dynamics of  $R^2$  coefficients.

### 4.1 Daily regressions for stocks

In this section we use two parallel approaches: in the first one we obtain  $R^2$  for each stock and the simple average of the stocks included in the sample (for the sake of brevity we will call it  $INDEX_{eq}$ ). In the second approach, the market liquidity index is obtained as a weighted average of the liquidity measures of stocks, where weights are time-varying on a daily basis dependently of the turnover in a given day ( $INDEX_w$ ). Table 2 presents the results. The average value of the  $R^2$  coefficients from commonality regressions are very low, ranging from 1% ( $BAS$ ) to 8% ( $CS$ ) for equally weighted index and from 3% ( $LIX$ ) to 6% ( $HLR$ ) for market-value weighted index.

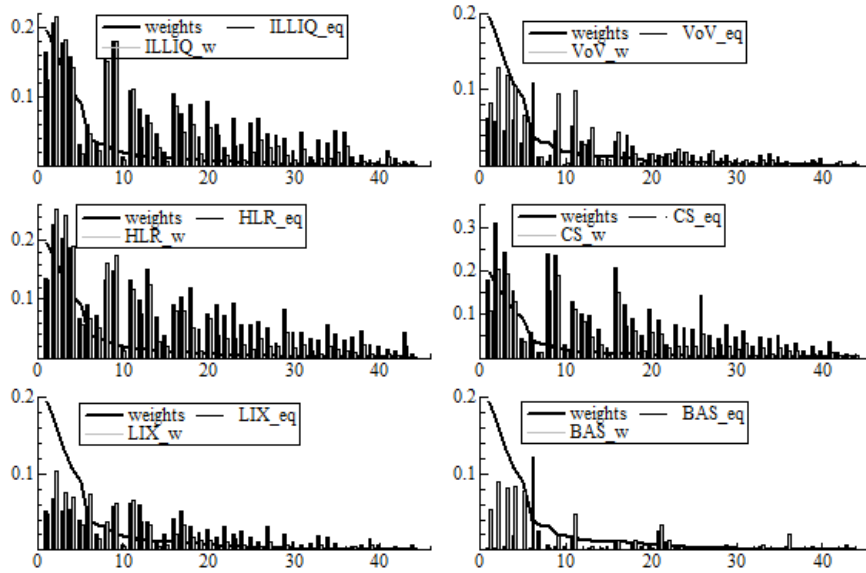
**Table 2.** Descriptive statistics of  $R^2$  coefficients from the commonality regressions

	$INDEX_{eq}$					$INDEX_w$				
	mean	st.dev.	0.25	0.5	0.75	mean	st.dev.	0.25	0.5	0.75
$R^2_{ILLIQ}$	0.06	0.05	0.02	0.05	0.08	0.04	0.05	0.01	0.02	0.05
$R^2_{HLR}$	0.02	0.02	0.01	0.01	0.03	0.03	0.04	0.00	0.01	0.03
$R^2_{CS}$	0.07	0.05	0.04	0.06	0.09	0.06	0.06	0.01	0.03	0.07
$R^2_{VoV}$	0.08	0.07	0.03	0.06	0.10	0.05	0.05	0.02	0.03	0.06
$R^2_{LIX}$	0.03	0.02	0.01	0.02	0.04	0.02	0.03	0.00	0.01	0.03
$R^2_{BAS}$	0.01	0.01	0.01	0.02	0.05	0.02	0.04	0.01	0.01	0.03

Note: The values in the table are the mean, standard deviations (st.dev.) and 25<sup>th</sup>, 50<sup>th</sup> and 75<sup>th</sup> percentile of the distribution of  $R^2$  from commonality regressions estimated on daily data

within the whole sample period for liquidity proxies.  $INDEX_{eq}$  stands for the liquidity index with equal weights, while  $INDEX_w$  stands for the market-value weighted liquidity index.

We have ordered stocks with respect to their average capitalization within the sample period measured by the daily turnover for each stock with respect to whole portfolio of 44 stocks. Figure 2 shows the average weight in the portfolio of a given stock within the whole sample period, the average  $R^2$  from commonality regressions with  $INDEX_{eq}$  as the independent variable, and average  $R^2$  from commonality regressions with  $INDEX_w$ . The results are presented for each stock in the form of two bars; stocks are presented in descending order of the market value at the end of 2016. The first two bars are the determination coefficients  $R^2$  from commonality regressions for the biggest stock, the last two are for the smallest one in the sample.



**Fig. 2.** The average  $R^2$  of commonality regressions for different liquidity proxies and the average stocks weights in the portfolio.

*Note:* The blue line shows the weights in the portfolio for each of the 44 stocks. Each stock gets two bars: the black bar is for the  $R^2$  from commonality regression for a given stock and equally weighted index  $INDEX_{eq}$ , while the grey bar is representing  $R^2$  from regressions with market-value weighted index  $INDEX_w$ .

We present the results ranking firms from the largest to the smallest ones – this ranking is based on the average capitalization within the sample period. Figure 2 shows that generally  $R^2$  from commonality regressions for different liquidity measures are low; in majority of cases they do not exceed 0.2. The highest values of  $R^2$  are observed for CS, while the lowest are found in case of BAS. There are visible



differences between  $R^2$  from both types of commonality regressions, but no single pattern is noticeable. When size is taken into account we find that for the big firms commonality measured by the  $R^2$  coefficient is larger than for the smaller firms. This conclusion is robust to the method of the index calculation: liquidity measures of the small firms are less correlated with both liquidity indices than liquidity measures of the big firms. With minor exceptions, this rule applies to all measures employed in the study. It is the mostly recognized in the case of *BAS* measure, where for the majority of the stocks  $R^2$  is close to 0.

## 4.2 Coherence of the Aggregate Measures

We also examine the commonality of the particular liquidity measures across the sample using the Spearman rang correlations. Thus we take into account the differences of liquidity proxies and calculate the correlations for each proxy separately for all stocks in the sample. Table 4 presents the cross-section sample descriptive statistics (the means, the standard deviations, 25<sup>th</sup>, 50<sup>th</sup> and 75<sup>th</sup> percentiles) of Spearman rang correlations. The correlations on average are positive, but low, below 10%. In many particular cases (not shown in the Table 3) they are not significantly different from zero.

In order to differentiate between big and small companies we consider separately the four biggest (10%) and four smallest (10%) companies in the sample. Last three columns of the Table show medians for these two groups as well as the Mann-Whitney test for medians' differences. The results show that for each proxy in case of big companies the median Spearman rang correlations are statistically higher than for the small firms. This is a rather remarkable result and confirm the findings from Section 4.1: commonality is stronger for the big companies than for the small ones.

**Table 3.** The descriptive statistics of cross section of Spearman rang correlations

Liquidity proxy	mean	st.dev.	25%	50%	75%	Median for 4 big stocks	Median for 4 small stocks	Z-score
ILLIQ	0.07	0.15	0.02	0.04	0.07	0.05	0.01	12.04
VoV	0.09	0.15	0.03	0.05	0.09	0.10	0.03	12.74
HLR	0.07	0.15	0.03	0.05	0.07	0.07	0.02	11.00
CS	0.06	0.15	0.01	0.03	0.05	0.05	0.01	10.36
LIX	0.06	0.15	0.02	0.04	0.06	0.03	0.01	7.27
BAS	0.05	0.16	0.00	0.02	0.04	0.03	0.01	7.27

*Note:* The values are descriptive statistics of the cross section of Spearman rang correlations between given liquidity proxies obtained for each stock in the sample. Z-score are the values of the Mann-Whitney statistics for the big and small stocks medians differences.

### 4.3 Monthly Dynamic R Squares: is Commonality Higher in Low Liquidity Periods?

In this section we consider coefficients from commonality regressions estimated in monthly windows and thus are able to examine the stability of  $R^2$  in changing market conditions. Within our sample period there occurred few serious market downturns on the global market. We test the hypothesis that the commonality in the liquidity measures is stronger in the time of the market downturns than in the calm periods. Thus we employ the commonality regressions to the daily innovations in liquidity proxies for individual stocks and innovations for the market liquidity (Eq.2) for each month separately and calculate the averages across the sample.

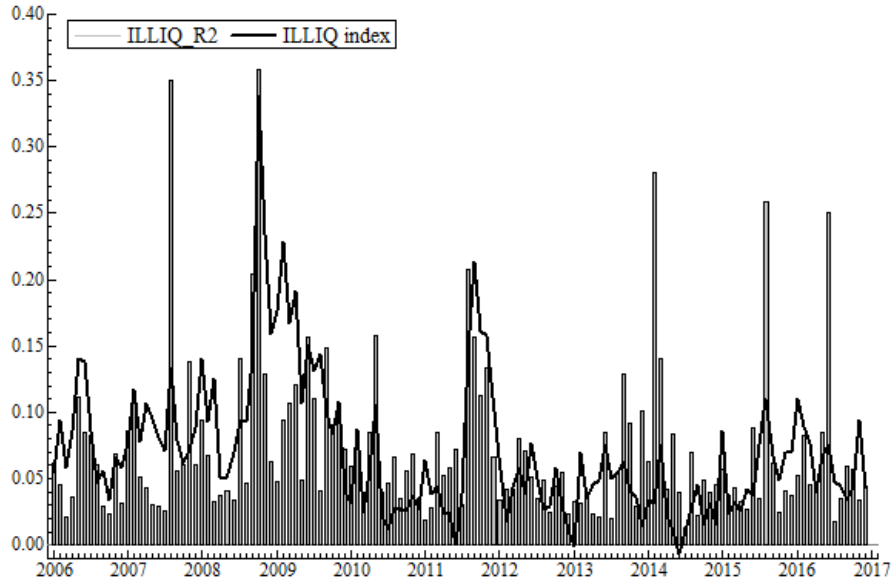
Table 4 presents the descriptive statistics for the monthly  $R^2$  from commonality regressions. The average values in the dynamic approach are higher than in the static one (see Table 2), but still low, and range from 4% for *BAS* spreads to 11% for Amihud illiquidity, *ILLIQ*. Some asymmetry in the distribution is observed for *ILLIQ*, *HLR* and *CS* as the medians are lower than the means.

**Table 4.** The descriptive statistics of cross section of Spearman rang correlations.

	mean	st.dev.	25%	50%	75%
$R^2_{ILLIQ}$	0.11	0.12	0.07	0.09	0.13
$R^2_{HLR}$	0.07	0.12	0.04	0.05	0.08
$R^2_{CS}$	0.09	0.13	0.04	0.06	0.10
$R^2_{VoV}$	0.05	0.10	0.03	0.05	0.06
$R^2_{LIX}$	0.05	0.10	0.04	0.05	0.06
$R^2_{BAS}$	0.04	0.09	0.02	0.03	0.05

This is in contradiction with the results of Karolyi et al. [12], who focus on commonality in Amihud liquidity and for the Polish stocks find the  $R^2$  coefficients' mean as high as 22% with standard deviation of 4.91% [12].

The next section of the study is devoted to the examination if the changes of the monthly indices built upon the various proxies are interrelated to the changes in  $R^2$  coefficients from the respective commonality regressions. Thus we are able to check if the increase in commonality is observed at the time of the increase in illiquidity. In this part we consider sample medians of the  $R^2$  from the commonality regressions with equally weighted indices as an independent variable. Figure 3 shows the dynamics of the cross-sectional average of  $R^2$  for innovations from *ILLIQ* proxy (Eq. 2) and the *ILLIQ* liquidity index. The values of  $R^2$  are changing from one month to another. They also comove with the index values.



**Fig. 3.** The dynamics of commonality (Amihud illiquidity) and illiquidity index.

To better illustrate this potential co-movement between commonality and indices, we calculate the Spearman rang correlations between the series of average monthly  $R^2$  and each liquidity index. The results presented in Table 5 are ambiguous: for three liquidity proxies, *ILLIQ*, *HLR* and *CS*, the correlations are positive and statistically significant, while the remaining proxies the correlations between indices and  $R^2$  from the regressions for the respective proxies are not statistically significantly different from zero.

**Table 5.** The descriptive statistics of cross section of Spearman rang correlations.

Liquidity Index:	$I_{ILLIQ}$	$I_{VOV}$	$I_{HLR}$	$I_{CS}$	$I_{LIX}$	$I_{BAS}$
Spearman rang correlation	0.4475	-0.0958	0.2956	0.3467	0.1771	0.0214
<i>p-value</i>	0.0000	0.2742	0.0006	0.0001	0.8716	0.8069

In order to deepen the analysis we look for the coexistence of the extreme values of commonality. Thus we search for the months in which for at least two proxies the values of  $R^2$  coefficients were among the five highest. Table 6 summarizes the results showing that there are five such months. The coefficients obtain the highest values in the crisis periods, e.g. August 2007 (BNP Paribas suspended three funds), October 2008 (downturn on the WSE resulting from the Lehman Brother collapse in September 2008), May 2010 (first bailout in Greece) or June 2016 (China debt crisis). The latter is the winner of the game with four cases where the coefficients belong to the five highest values in the whole sample. These results confirm that commonality of liquidity increases in hectic periods and decrease in the calm periods.

**Table 6.** The months in which commonality obtains the extreme values.

date	$R_{ILLIQ}^2$	$R_{VoV}^2$	$R_{HLR}^2$	$R_{CS}^2$	$R_{LIX}^2$	$R_{BAS}^2$
2007-08	0.32		0.24	0.47		
2007-12		0.16			0.11	
2008-10	0.31		0.28	0.36		
2010-05		0.13			0.13	
2016-06	0.28		0.43	0.54		0.14

*Note:* The values in the Table are the highest  $R^2$  that occurred at the same time in at least two series. First column shows in which month this event appeared.

## 5 Conclusions

This paper is devoted to the examination of the commonality in liquidity observed in the emerging European order-driven market. In this study we examine the market-wide movements of liquidity measures calculated for stocks quoted on the Warsaw Stock Exchange within 2006-2016 period. Six liquidity proxies are considered and two liquidity indices are constructed, a simple aggregate and turnover weighted aggregate.

We show that commonality in liquidity measures is rather weak as the determination coefficients in commonality regressions are low (usually lower than 10%). The average commonality for different proxies differ, the highest values are observed for high-low range and Amihud illiquidity, and the lowest for spread calculated on the basis of intraday data. This evidence suggests that commonality in liquidity measures is less pronounced than it was shown by the previous studies and is much weaker than on the developed markets.

This could lead to the conclusion that on the Polish capital market liquidity risk is more idiosyncratic than systemic. But, we find that commonality depends on the firm size: the biggest firms in our sample show much more commonality than the smaller firms. Additionally, our results indicate that commonality is time-varying, specifically it increases in the periods in which liquidity dries up. These two results together might offer an interesting explanation of the commonality behavior: stocks of big firms are bought by financial intermediaries more often than stocks of small ones. In market downturns the intermediaries withdraw funds from the market, and this effects mainly these big firms in which they invested. This withdraw of the funds causes a decrease in liquidity. The less liquidity is supplied, the higher is the commonality, but it concerns mostly the big firms. Thus the liquidity risk for a big firms' segment of the market seems to be systemic.

**Acknowledgements.** This work was supported by the Polish National Science Centre under the grant no. UMO-2017/25/B/HS4/01546.

## References

1. Batten, J.A., Szilagyi, P.G.: The Impact of the Global Financial Crisis on Emerging Financial Markets: Introduction. In: Batten, J.A. and Kearney, C. (eds.) *The Impact of the Global Financial Crisis on Emerging Financial Markets*. pp. 3–16 Emerald Group Publishing Limited, Bingley, UK (2011).
2. Będowska-Sójka Barbara: How Jumps Affect Liquidity? The Evidence from Poland. *Finance a uver Czech Journal of Economics and Finance* 67(1), 39–52 (2017).
3. Brownlees, C.T., Gallo, G.M.: Comparison of volatility measures: A risk management perspective. *Journal of Financial Economics* 8(1), 29–56 (2009). DOI: 10.1093/jjfinec/nbp009.
4. Chordia, T. et al.: Commonality in liquidity. *Journal of Financial Economics* 56, 3–28 (2000).
5. Corwin, S.A., Schultz, P.: A simple way to estimate bid-ask spreads from daily high and low prices. *Journal of Finance* 67(2), 719–759 (2012). DOI: 10.1111/j.1540-6261.2012.01729.x.
6. Coughenour, J.F., Saad, M.M.: Common market makers and commonality in liquidity. *Journal of Financial Economics* 73(1), 37–69 (2004). DOI: 10.1016/j.jfineco.2003.05.006.
7. Fong, K.Y.L. et al.: Are volatility over volume liquidity proxies useful for Global or US research. (2017).
8. Fong, K.Y.L. et al.: What are the best liquidity proxies for global research? *Review of Finance* 1–47 (2017). DOI: 10.1093/rof/rfx003.
9. Goyenko, R.Y. et al.: Do liquidity measures measure liquidity? *Journal of Financial Economics* 92(2), 153–181 (2009). DOI: 10.1016/j.jfineco.2008.06.002.
10. Hameed, A. et al.: Stock market declines and liquidity. *Journal of Finance* 65, 1, 257–293 (2010). DOI: 10.1111/j.1540-6261.2009.01529.x.
11. Hasbrouck, J.: Trading Costs and Returns for U.S. Equities: Estimating Effective Costs from Daily Data. *Journal of Finance* 64(3), 1445–1477 (2009).
12. Karolyi, G.A. et al.: Understanding commonality in liquidity around the world. *Journal of Financial Economics* 105(1), 82–112 (2012). DOI: 10.1016/j.jfineco.2011.12.008.
13. Karolyi, G.A., Stulz, R.M.: Why Do Markets Move together ? An Investigation of U.S.-Japan Stock Return Comovements. *Journal of Finance* 51(3), 951–986 (1996).
14. Kempf, A., Mayston, D.: Liquidity commonality beyond best prices. *Journal of Financial Research* 31(1), 25–40 (2008). DOI: 10.1111/j.1475-6803.2008.00230.x.
15. Kocinski, M.A.: On low-frequency estimation of bid-ask spread in the stock market. *Quantitative Methods in Economics* 15(2), 135–143 (2014).
16. Lesmond, D.A. et al.: A new estimate of transaction costs. *Review of Financial Studies* 12(5), 1113–1141 (1999). DOI: 10.1093/rfs/12.5.1113.
17. Naik, N.Y., Yadav, P.K.: Do dealer firms manage inventory on a stock-by-stock or a portfolio basis? *Journal of Financial Economics* 69(2), 325–353 (2003). DOI: 10.1016/S0304-405X(03)00115-6.
18. Olbryś, J.: Testing Stability of Correlations between Liquidity Proxies Derived from Intraday Data on the Warsaw Stock Exchange. In: Jajuga, K. et al. (eds.) *Contemporary Trends and Challenges in Finance. Proceedings from the 3rd Wrocław International Conference in Finance*. Springer Proceedings in Business and Economics. Cham: Springer, 67–79 (2018).
19. Zaremba, A., Czapkiewicz, A.: Digesting anomalies in emerging European markets: A comparison of factor pricing models. *Emerging Market Review* 31, 1–15 (2017). DOI: 10.1016/j.ememar.2016.12.002.

## Models and Forecasts of Wage Distributions in Czech Education and Health Care Sectors

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**Abstract.** This paper deals with the development of wages in Czech education and health care sectors since the beginning of the global economic crisis to the present. Data for this research come from the official website of the Czech Statistical Office and they include employees of the Czech Republic. The variable surveyed is the gross nominal monthly wage of the employee. The construction of wage models in Czech education and health care sectors that allow some comparison between education and health care sectors, is an important aim of this research. Three-parameter lognormal curves are the basis of these models. The construction of predictions not only the wage levels in the Czech education and health care sectors until 2020, but also of the predictions of the whole wage distributions in these two sectors until 2020 is a part of this study. Important aim is the construction of clusters of sectors that are the most similar according to average wage and selected variables.

**Keywords:** Wage Models, Lognormal Curves, Maximum Likelihood Method, Wage Predictions, Cluster Analysis.

### 1 Introduction

In general, employees performing psychologically demanding work achieve the highest wage levels, while employees performing physically demanding work achieve lower wage levels, and the highest monthly wage fluctuations are monitored for managers, whereas the smallest wage differences in monthly wages are detected for office workers and teachers, which are not very different throughout the whole Czech Republic.

Through the whole society, the opinion eternally prevails that education of the youngest generations is among the priorities, and work in education therefore deserves a solid reward.

For many years, governments in the Czech Republic have relied on the fact that if someone graduates from a Medical Faculty or Medical School, they will devote their profession even under a relatively small reward. Especially, if poetic slogans about the noble profession and help to sick are added to it. After all, this is not even work, but this is a mission. If someone decides to join his (her) professional life with health care already in youth and successfully passes through the pitfalls of the appropriate

educational institutions, it is very likely that they will remain in health care in decent working conditions. However, non-health workers are necessary for the reliable functioning of hospitals, too. Drivers, cooks, caretakers, helpers, hospital attendants and many other professions. And the labour market hand is starting to threaten here.

This paper focuses on research of wage development in Czech education and health care sectors since the beginning of the global economic crisis to the present. The aim is to capture the predictions until 2020, not only predictions of wage level, but also predictions of the whole wage distributions, since it is necessary to know the full wage distribution of the population from the point of view of a correct evaluation of the wage aspect of the standard of living of the population and within correct decisions in terms of steps in this area. Important aim is the construction of clusters of sectors that are the most similar according to average wage and selected variables in 2017.

Although the beginning of the global economic crisis can be dated to the autumn of 2008, so the consequences of its accession were economically manifested especially in 2009. For this reason, the study covers the period 2009–2017 with predictions for the period 2018–2020.

## 2 Data Base

Data for this research come from the official website of the Czech Statistical Office (CSO). There are annual data in the form of an interval frequency distribution with extreme open intervals. The researched variable is the gross (nominal) monthly wage in CZK. Employees of the Czech Republic represent the statistical units surveyed.

**Table 1.** Exact and abbreviated (modified) names of the sectors analysed [1].

Exact name	Modified name
Education	Education system
Human health and social work activities	Health service
Financial and insurance activities	Finance and insurance
Information and communication	Informatics and communications
Accommodation and food service activities	Accommodation activities
Administrative and support service activities	Administrative activities

]

Data from the CSO include employees in the business and non-business sphere in the Czech Republic. The wage is paid to the employee for the work done in the private (business) sphere, the salary in the budget (state, public, non-business) sector. In general, salaries in the non-business sphere are much more nivelised than wages in the business sphere, where very high wage variability exists. In terms of data presented on the CSO website, wages in the business sector and salaries in the non-business sector are below the wage term.

Abbreviated (modified) names of the analysed sectors are used in the following text (figures and tables). The exact names according to the official CSO website and abbreviated (modified) names of the analysed sectors are presented in Table 1.

### 3 Theory and Methods

Wage distribution models are based on the construction of three-parameter lognormal curves, the parameters of which are estimated using maximum likelihood method. Three-parameter lognormal distribution is defined with probability density function

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

$$= 0, \quad \text{otherwise.}$$

The essence of three-parameter lognormal curves used in modelling wage distributions is explained in [3] or [5] and the essence of the maximum likelihood method used for point parameter estimation of these lognormal curves is explained in [4]. For a given parameter  $\theta$  (minimum wage), the estimates of the remaining two parameters of three-parameter lognormal curves are taken using

$$\hat{\mu}(\theta) = \frac{\sum_{i=1}^n \ln(x_i - \theta)}{n}, \quad (2)$$

$$\hat{\sigma}^2(\theta) = \frac{\sum_{i=1}^n [\ln(x_i - \theta) - \hat{\mu}(\theta)]^2}{n}. \quad (3)$$

The essence of time series analysis and their simple characteristics are explained in [6]. The predictions of wage level (average and median-middle gross monthly wage) by sectors until 2020 were created on basis of the respective time series from the period 2009–2017. In the context of trend development, exponential smoothing was applied in time series analysis. Exponential smoothing is one of the adaptive approaches to modelling time series and it uses the weighted least square method, where scales exponentially decreasing towards the past. The advantage of exponential smoothing lies in the fact that the most recent observations have the highest weight. Appropriate exponential smoothing was chosen using interpolation criteria. The statistical software automatically evaluates the most advantageous combinations of equalizing constants  $\alpha$  and  $\beta$ . Sample residual autocorrelation functions and sample residual partial autocorrelation functions show that the non-systematic component does not show autocorrelation in all cases, and consequently the relevant exponential smoothing is satisfactory. The Durbin-Watson statistics are close to two in all cases,



i.e. always in the interval (1.6, 2.4). Random faults can be therefore considered as independent. It can be approached to using Theil coefficient of mismatch to evaluate the model's quality. The annual time series are abbreviated of  $m$  observations (in this case,  $m = 3$  observations), with forecasts for these  $m = 3$  years being made using the corresponding exponential smoothing. Theil coefficient of mismatch gets the low zero boundary only in case of flawless forecasts. The more the Theil coefficient of mismatch deviates from zero, the more the prediction differs from ideal flawless prognoses. The square root of the Theil mismatch coefficient can be interpreted as a relative prediction error. All calculated values of Theil mismatch coefficient and relative prediction error indicate the high quality of the selected exponential smoothing models. The essence of cluster analysis is explained in detail for example in [2], and Ward's method and Euclidean distance were used, since there are the most widely used techniques within cluster analysis, and number of clusters was determined five using Dunn index.

## 4 Results and Discussion

Figures 1–4 offer an idea of the development of the entire wage distribution of the health care sector and the education sector over time, and they allow a comparison of the wage distribution shape for these two sectors over time. There are model wage distributions constructed using three-parameter lognormal curves, since empirical wage distributions could not be used for the reason of unequally wide intervals of empirical distributions with extreme open intervals. The values in Table 2 were calculated from these model distributions.

From Table 2, the shift in wage distributions is evident in both sectors between the period of the global economic crisis and the present. For example, while in 2009, 16.8 % of employees in the education sector reached a maximum wage of 15,000 CZK, in 2014, after the crisis, this share fell to 13.7 % and in 2017 even to 4.4 %. In health care sector, in 2009, 21.2 % of employees reached a maximum wage 15,000 CZK, in 2014, after the crisis, this share fell to 17.1 % and in 2017 even to 4.9 %.

It is evident from Table 2, that approximately 64.8 % of employees in education sector and 63.7 % of employees in health care sector had their gross monthly wage lower or at most equal to the countrywide average gross monthly wage in 2017. This means that approximately two-thirds of employees in both analysed sectors did not achieve average wage in 2017. On the contrary, the share of employees whose gross monthly wage exceeded CZK 100,000 does not exceed 1 % over the whole analysed period for both sectors. Therefore, we do not see any significant changes at higher wage limits throughout the whole period.

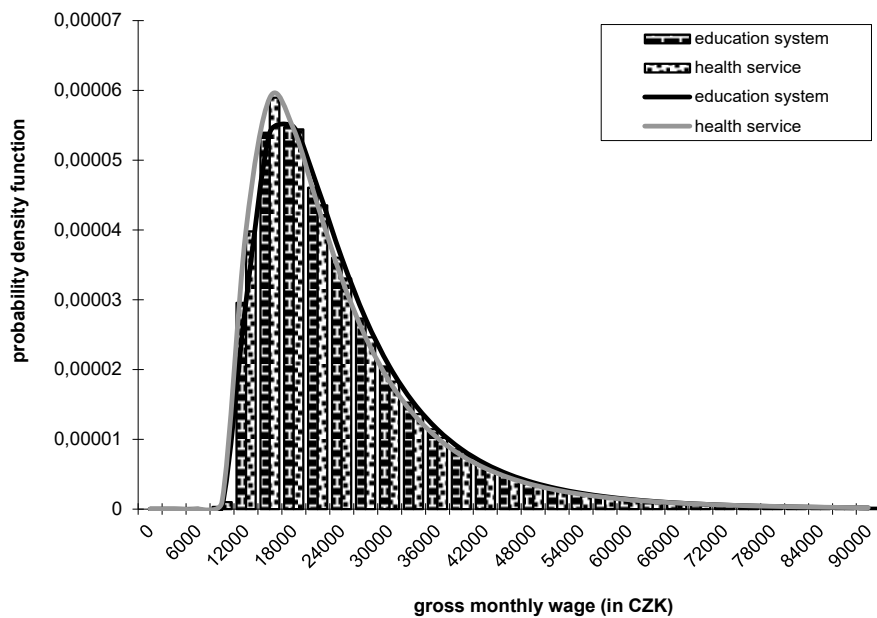


Fig. 1. Model distribution of gross monthly wages in the education and health sectors in 2009.

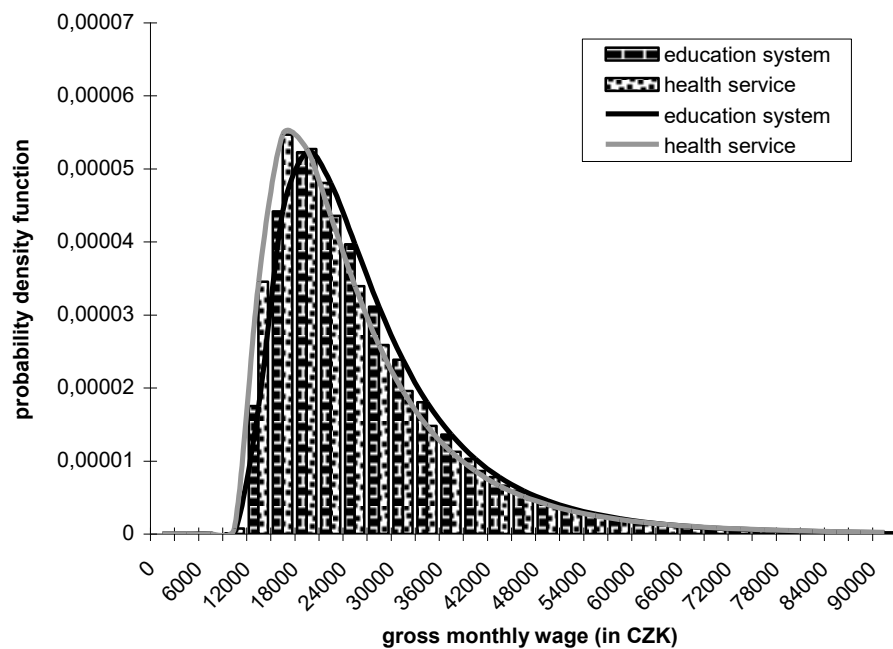
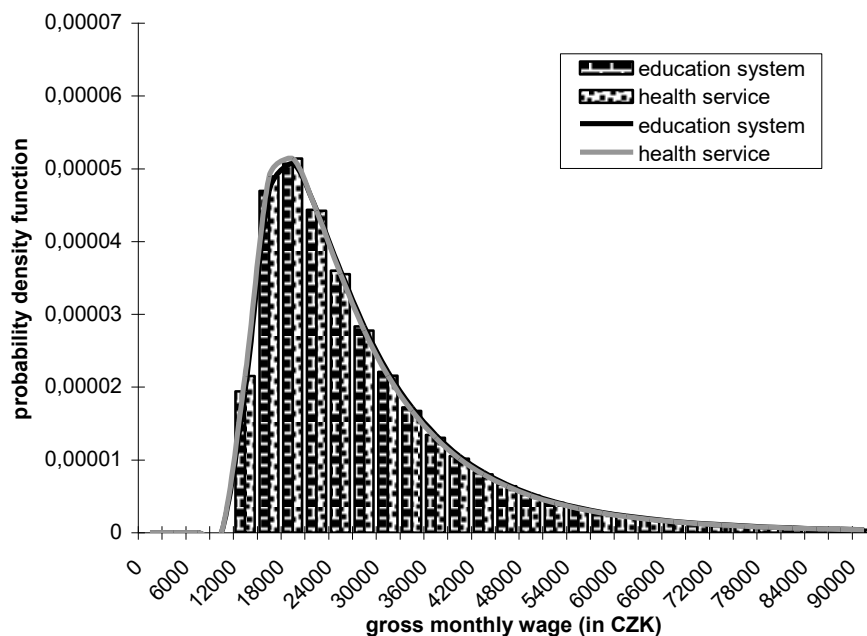
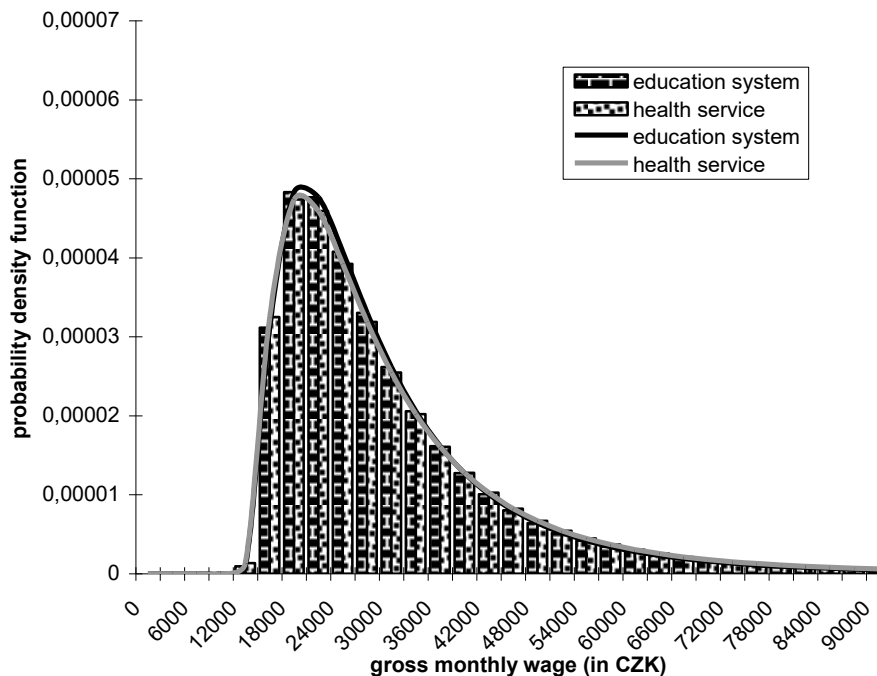


Fig. 2. Model distribution of gross monthly wages in the education and health sectors in 2011.



**Fig. 3.** Model distribution of gross monthly wages in the education and health sectors in 2015.



**Fig. 4.** Model distribution of gross monthly wages in the education and health sectors in 2017.

**Table 2.** Estimated proportions (in percentages) of employees whose gross monthly wage reaches at most upper wage limit in 2009, 2014 and 2017.

Upper limit	Education system			Health service		
	2009	2014	2017	2009	2014	2017
15,000	16.8	13.7	4.4	21.2	17.1	4.9
20,000	44.0	39.0	26.7	48.7	44.0	27.0
30,000	77.6	73.1	64.8	79.7	76.5	63.7
40,000	90.7	87.7	82.8	91.4	89.6	81.5
50,000	95.8	94.0	91.0	96.0	95.0	89.9
60,000	98.0	96.9	95.0	98.0	97.4	94.2
70,000	99.0	98.3	97.1	98.9	98.6	96.5
80,000	99.4	99.0	98.2	99.4	99.2	97.8
90,000	99.7	99.4	98.9	99.7	99.5	98.6
100,000	99.8	99.6	99.3	99.8	99.7	99.0

Figures 5 a 6 demonstrate illustrations of exponential smoothing of time series of average wage for education and health care sectors, where Brown's quadratic exponential smoothing was chosen as the most appropriate in time series of education sector and Holt's linear exponential smoothing was chosen as the most appropriate in time series of health care sector. This was done analogically in terms of exponential smoothing for median wage, wage standard deviation (necessary for the construction of the prediction of the whole wage distributions until 2020) in both sectors and national average wage (necessary for construction of predictions of national average wage until 2020). The value of 32,456 was used for the estimation of minimum wage for 2020.

Based on this trend analysis of the corresponding time series, the predictions of average and median gross monthly wages for both analysed sectors were constructed, see Table 3. We can see from this table that we can expect gradual growth of wage levels in both sectors until 2020, where growth of wage level is expected to be faster in health care sector (on average more than 3 % per annum) than in education sector (on average about 2 % per annum).

The minimum wage in 2018 was 12,200 CZK. The government's planned valorisation of the minimum wage for 2019 is CZK 13,200. The government of the Czech Republic expects that the minimum wage could be regularly valorised from 2020 onwards. This would be based on the average wage and set as its 0.44 times. For this reason, the assumed minimum wage for 2020 was estimated to be 0.44 times the projected national average wage (Table 4) in this year

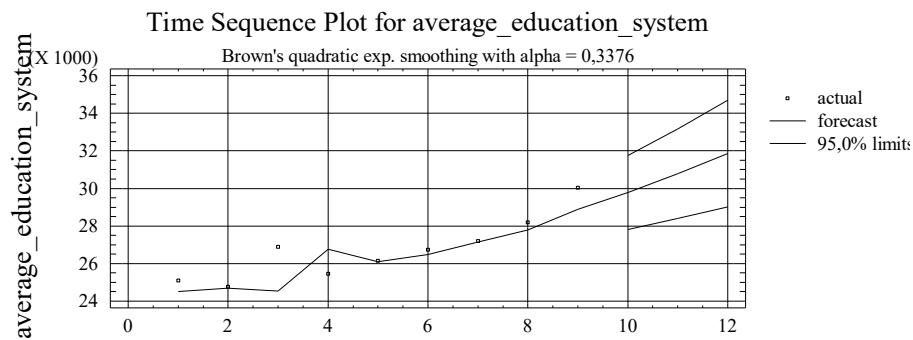
$$32,456 * 0.44 = 14,280.64 = 14,300 \text{ CZK.} \quad (4)$$

**Table 3.** Prediction of wage level development (in CZK) and wage variability development (standard deviation in CZK, coefficient of variation in percentages) to 2020 for education and health care sectors.

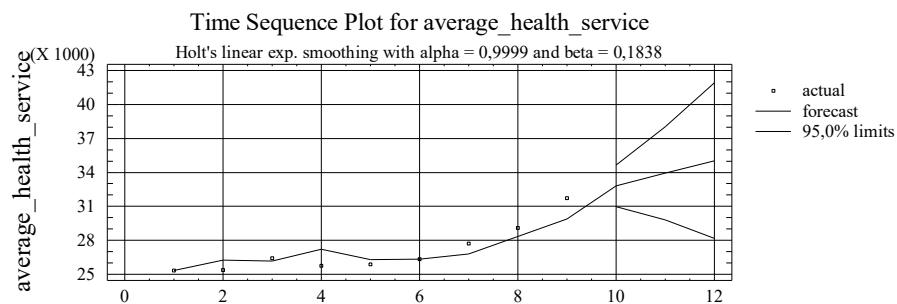
Year	Education sector				Health care sector			
	Average	Median	Std. d.	Var. c.	Average	Median	Std. d.	Var. c.
2018	29,778	28,306	14,881	49.97	32,816	28,031	20,278	61.79
2019	30,771	29,217	15,056	48.93	33,926	28,965	20,981	61.84
2020	31,862	30,216	15,230	47.80	35,036	29,898	21,685	61.89

**Table 4.** Prediction of national average wage development (in CZK) to 2020.

Year		
2018	2019	2020
30,110	31,283	32,456

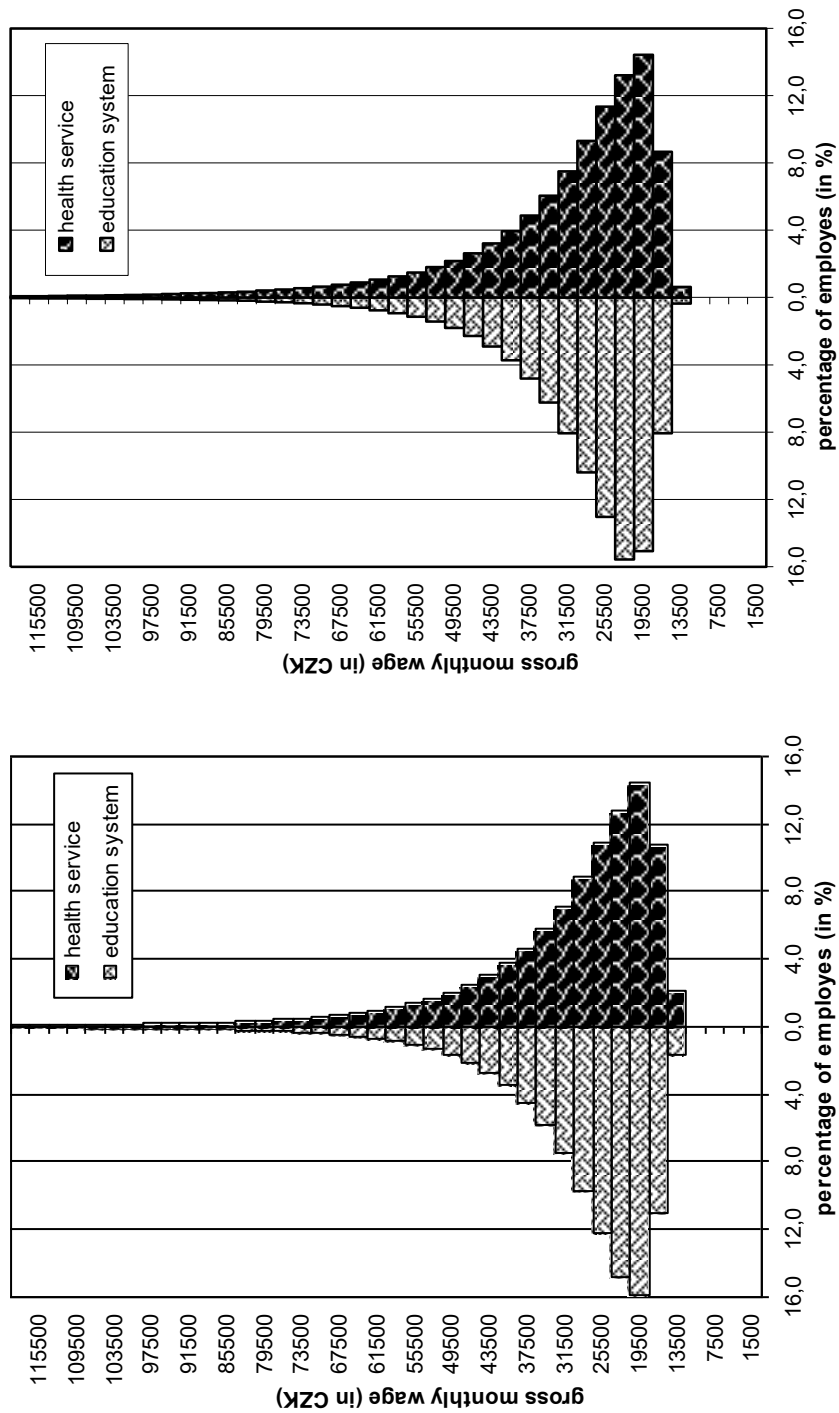


**Fig. 5.** Brown's quadratic exponential smoothing – average of education sector.



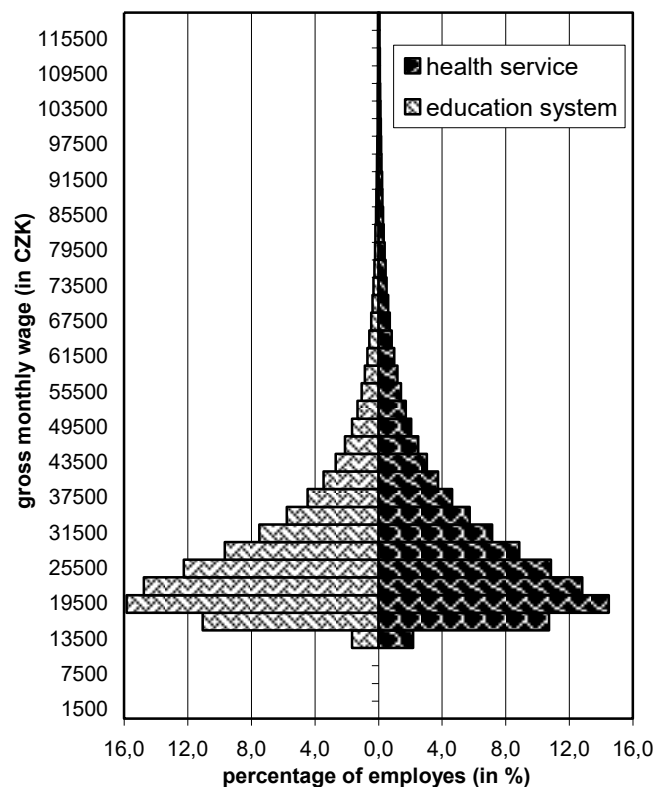
**Fig. 6.** Holt's linear exponential smoothing – average of health care sector.

Figures 7–9 represent predictions of the full wage distributions for the education and health care sectors until 2020. Middles of wage intervals with wide of 3,000 CZK are on the vertical axis of Fig. 7–9.



**Fig. 8.** Prediction of the distribution of the gross monthly wage (in percentages) for education and health care sectors for the year 2019.

**Fig. 7.** Prediction of the distribution of the gross monthly wage (in percentages) for education and health care sectors for the year 2018.

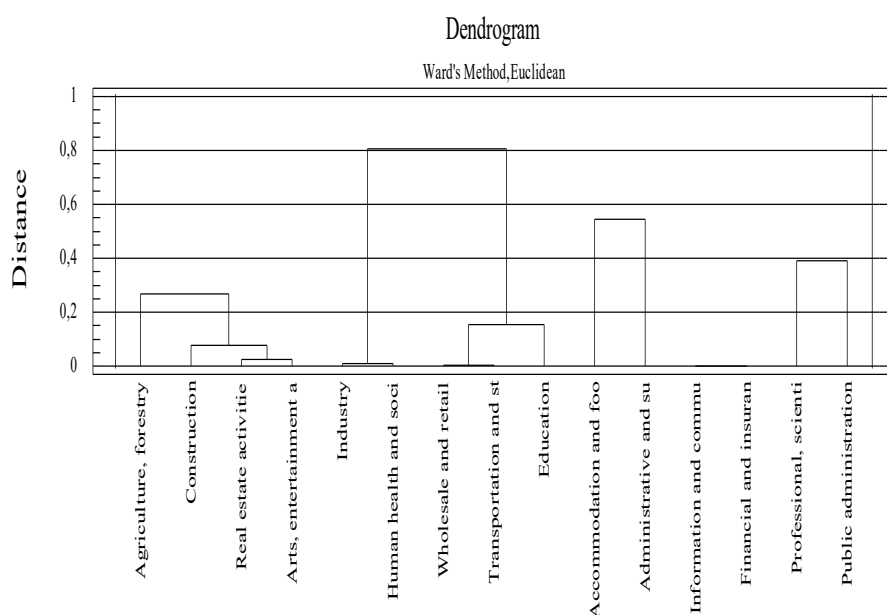


**Fig. 9.** Prediction of the distribution of the gross monthly wage (in percentages) for education and health care sectors for the year 2020.

We can see from these figures a higher percentage representation of lower wage intervals for the education sector compared to the health care sector and a higher percentage representation of higher wage intervals for health care sector compared to the education sector. This situation is probably related to the expected higher wage level in the health care sector than in the education sector over the next three years. The zero percentage representation at the lowest wage intervals is related to the existence of a minimum wage institute and its gradual increase.

Figure 10 shows the results of cluster analysis applied to all sectors of the Czech economy based on cross-sectional data. We can see from this figure that the first cluster has four members: 1. Agriculture, forestry and fishing; 2. Construction; 3. Real estate activities; 4. Arts, entertainment and recreation. The second cluster is five-membered: 1. Industry; 2. Wholesale and retail trade; repair of motor vehicles and motorcycles; 3. Transportation and storage; 4. Education; 5. Human health and social work activities. This means that the two sectors analysed in this study are in the same cluster. The third cluster contains only two the worst-paid sectors: 1. Accommodation

and food service activities; 2. Administrative and support service activities. On the contrary, the fourth cluster contains two the best-paid sectors: 1. Information and communication; 2. Financial and insurance activities. The fifth cluster has the two remaining clusters: 1. Professional, scientific and technical activities; 2. Public administration and defence; compulsory social security.



**Fig. 10.** Dendrogram of the results of cluster analysis: Clusters of all sectors of the Czech economy that are the most similar according average wage and related indicators in 2017.

## 5 Conclusion

The big problem in these sectors is probably the above-average high tax on labour, which drains from the net income of the people, and at the same time it demotivates employers from adding to employees. There is no way in increase of the minimum wage. If we want in order that people will take more money, we need to increase the productivity. At first people must get rich, otherwise the country is not rich. The recipe may consist in a reduction in load levies. At present, a very good situation is for people who want to change their job title. Wages in the Czech Republic are considerably underestimated over other European Union countries. Trade unions play an important role here as they help to exert pressure to increase wages.

Wages in the health care sector are slightly more differentiated, while wage diversification is roughly the same in both sectors, and for the future, greater wage diversification is expected for the health care sector than for the education sector. At present, about two-thirds of employees in the education and health care sectors have



a lower their gross monthly wage than the national average gross monthly wage in the Czech Republic. We can expect a gradual increase in wage levels in the education and health sectors until 2020. The average gross monthly wage in these two sectors is approximately the same as in sectors of industry, wholesale and retail trade, repair of motor vehicles and motorcycles and transportation and storage.

Now it is necessary to increase nurses' tariffs. It is important that young doctors and qualified nurses do not leave abroad immediately after school. The biggest problem is the lack of nurses at present. Systemic arrangements, such as tariff settlements or surcharges for work shifts of inpatient care, have not been addressed in the last electoral period. Health care and education sectors would be given a priority in terms of wage increases. In the Czech Republic, this would also strengthen the role of primary care because hundreds medical practitioners lack. In addition, the average age of medical practitioners ranges from 58 to 59 years.

**Acknowledgements.** This paper was subsidized by the funds of institutional support of a long-term conceptual advancement of science and research number IP400040 at the Faculty of Informatics and Statistics, University of Economics, Prague, Czech Republic.

## References

1. Český statistický úřad, <http://www.czso.cz>, last accessed 2018/11/21.
2. Everitt, B. S., Landau, S., Leese, M., Stahl, D.: Cluster Analysis. 5th edn. John Wiley & Sons Ltd., West Sussex (2011).
3. Johnson, N. L., Kotz, S., Balakrishnan, N.: Continuous Univariate Distributions, Vol. 1. 2nd edn. Wiley-Interscience, New York (1994).
4. Johnson, N. L., Kotz, S., Balakrishnan, N.: Continuous Univariate Distributions, Vol. 2. 2nd edn. Wiley-Interscience, New York (1995).
5. Kleiber, C., Kotz, S.: Statistical Size Distributions in Economics and Actuarial Sciences. 1st edn. Wiley-Interscience, New York (2003).
6. Shumway, R. H., Stoffer, D. S.: Time Series Analysis and Its Applications: With R Examples. 4th edn. Springer, New York (2017).

## Are Wages in Czech Education and Health Care Sectors the Same?

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**Abstract.** This paper deals with the development of wages in Czech education and health care sectors since the beginning of the global economic crisis to the present. Data for this research come from the official website of the Czech Statistical Office and they include employees of the Czech Republic. The variable surveyed is the gross nominal monthly wage of the employee. Capturing development in wage levels in these two sectors, including a comparison with two the best-paid and two the worst-paid sectors, is the main objective of this study, as the issue concerning wage in education and health care sectors is a frequently debated topic in the Czech Republic. Depiction of the development of wage differentiation and diversification characteristics in Czech education and health care sectors is no less important objective of this research. Data from the CSO include employees in the business and non-business sphere in the Czech Republic. The wage is paid to the employee for the work done in the private (business) sphere, the salary in the budget (state, public, non-business) sector. In terms of data presented on the CSO website, wages in the business sector and salaries in the non-business sector are below the wage term.

**Keywords:** Gross Monthly Wage, Average Wage, Median Wage, Gini Coefficient, Wage Diversification, Wage Differentiation.

### 1 Introduction

The situation regarding wages in education and health care sectors is very often discussed in the Czech Republic, as a large proportion of employees with tertiary education is employed here, but wages are relatively low compared to other sectors where people with completed university education are employed predominantly. The trend that people have dropped out their branch after graduation from Faculty of Education and run somewhere else because of low wages, is a relatively frequent phenomenon in the Czech Republic during the last period.

Education and health care sectors attract the attention of number of experts and scientists due to low wages in these two sectors of the Czech economy, where comparison with other countries being offered here. Comparison with other sectors is offered, too. For example, [2] treats the sector of employment as endogenous and

control for selectivity in the wage equations. There was found that wages of women in the private sector do not increase with experience or schooling. However, wages of men in the private sector increase with experience at a higher rate than in the public sector and increase with higher education at comparable rates in both sectors. [6] measures and decomposes the differences in earning distributions between public sector and private sector employees in Germany for the years 1984–2001. [5] states that quantile regression estimates of returns to education are used to address the relation between schooling and wage inequality. Empirical evidence for male workers from 16 countries for the mid-1990s suggests a robust stylised fact: Returns to schooling are higher for the more skilled individuals, conditional on their observable characteristics. [8] shows that the real wage rate for the unskilled workers has continued to fall. Factor share equations for skilled and unskilled labour are estimated, which show the rise in skilled wages leading to substitution to unskilled labour but no rise in the share of skilled labour in income. [7] deals with public sector wages and private sector in Latin America.

This paper focuses on research of wage development in Czech education and health care sectors since the beginning of the global economic crisis to the present. The aim is to capture the level and the differentiation of wages. A comparison of the wage levels in education and health care sectors with wage levels of two the best-paid sectors and of two the worst-paid sectors in the Czech economy is a part of this study.

Although the beginning of the global economic crisis can be dated to the autumn of 2008, so the consequences of its accession were economically manifested especially in 2009, when the Czech economy recorded a decline of 4.8 % as result of the global economic recession. For this reason, the study covers the period 2009–2017. The education and health care sectors are recently the most discussed sectors of the Czech economy with regard to the level of wages in these sectors in relation to the level of education of the majority of employees in both these sectors.

## 2 Data Base

Data for this research come from the official website of the Czech Statistical Office (CSO). There are annual data in the form of an interval frequency distribution with extreme open intervals. The researched variable is the gross (nominal) monthly wage in CZK. Employees of the Czech Republic represent the statistical units surveyed.

Data from the CSO include employees in the business and non-business sphere in the Czech Republic. The wage is paid to the employee for the work done in the private (business) sphere, the salary in the budget (state, public, non-business) sector. In general, salaries in the non-business sphere are much more nivelised than wages in the business sphere, where very high wage variability exists. In terms of data presented on the CSO website, wages in the business sector and salaries in the non-business sector are below the wage term.




Abbreviated (modified) names of the analysed sectors are used in the following text (figures and tables). The exact names according to the official CSO website and abbreviated (modified) names of the analysed sectors are presented in Table 1.

**Table 1.** Exact and abbreviated (modified) names of the sectors analysed [1].

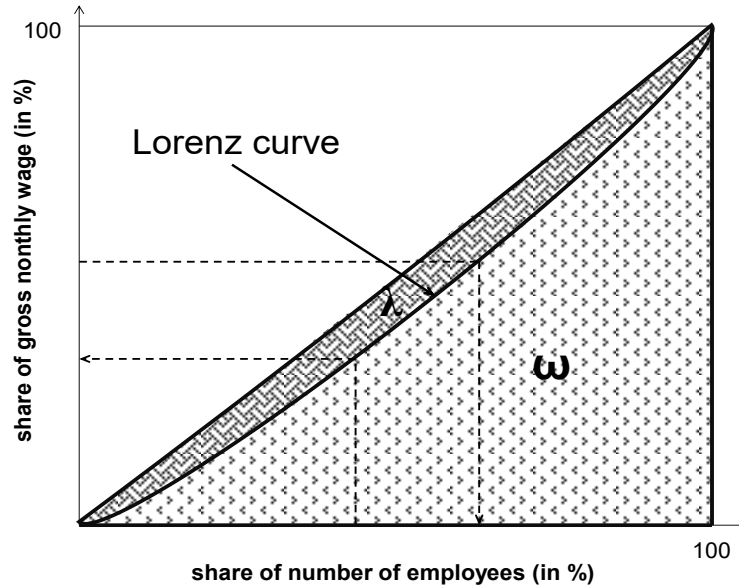
Exact name	Modified name
Education	Education system
Human health and social work activities	Health service
Financial and insurance activities	Finance and insurance
Information and communication	Informatics and communications
Accommodation and food service activities	Accommodation activities
Administrative and support service activities	Administrative activities

### 3 Theory and Methods

Simple descriptive characteristics are used to characterize the development of the empirical distribution of the gross monthly wage since 2009, see [4]. The Gini coefficient was used to characterize the development of the diversification of wage distribution of education and health care sectors in the given period.

The Gini coefficient is related to the famous Lorenz curve (see Fig. 1), which is indicated in bold here (including its two extreme alternative shapes in cases of both zero and maximum possible diversification). The Lorenz curve is plotted in a rectangular chart with two scales from zero to a hundred percent. Cumulative relative frequencies (in percentages of units) representing the research variable are on the horizontal coordinate axis. Employees represent the gross monthly wage variable in this case. Cumulative totals of the concentrated variable (in percentages) are located on the axis of ordinates, gross monthly wage being the concentrated variable in this case. Cumulative relative frequencies of units and their corresponding cumulative totals of the concentrated variable thus represent the coordinates of points on the Lorenz curve. The curve merges with the diagonal of the graph in the case of zero diversification, when the same proportion of the total sum of values of the research variable relates to each unit. This would be the case of all employees having the same gross monthly wage. The more the Lorenz curve bends, the higher is the diversification of the research variable, i.e. the concentration of a considerably large part of the total sum of variable values in a small number of statistical units. The highest diversification occurs when the total sum of values of the variable is concentrated into just a single unit. The Gini diversification coefficient is the ratio of the area content that defines the diagonal of the graph and the Lorenz curve, which indicates  ( $\lambda$ ) in Fig. 1, and the content of the total area of the triangle below the diagonal, which is indicated by an area of  +  ( $\lambda + \omega$ ) in Fig. 1

$$G = \frac{\lambda}{\lambda + \omega}. \quad (1)$$

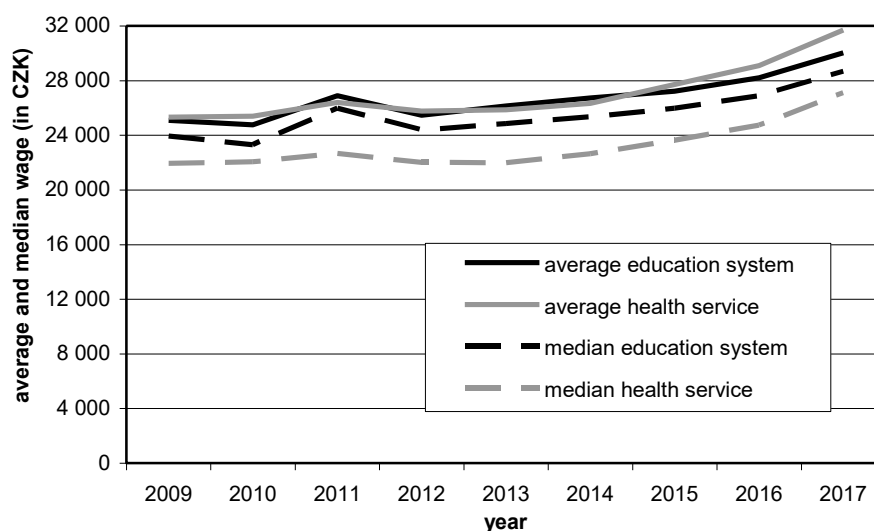


**Fig. 1.** Lorenz curve [3].

The value of the Gini coefficient after multiplying by one hundred thus ranges from zero to one hundred percent; i.e. from extreme levelling (zero diversification), where all employees have the same wage, to extreme diversification (maximum possible concentration), where the whole wage belongs to one employee.

#### **4 Results and Discussion**

Figure 2 represents the development of the wage level in education and health care sectors. We can see from this figure that the wage level is approximately the same in both sectors analysed. Figure 3 is related to Fig. 2. Both these figures show a significant rise in wages in the education sector in 2011, which is probably due to a significant increase in wages especially for young teachers at the beginning of 2011. We observe the annual growth rate of average wage in the education sector of 8.57 % in 2011 and in median wage even 11.4 %.



**Fig. 2.** Development of average and median wage (in CZK) in education and health care sectors.

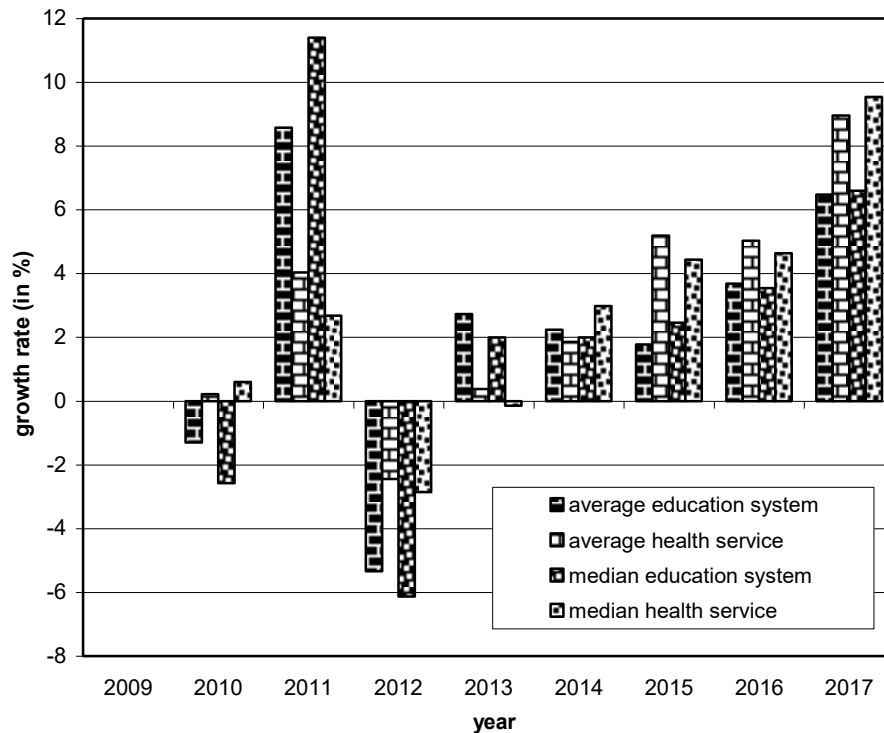
Similarly, we are seeing a certain boom in the wage level in 2011 for the health care sector, although this is not as significant as in education. This situation was probably caused by a significant wage increase of medical doctors of nearly 15 %. However, this figure applies only to the public health care sector, i.e. to medical doctors paid by the Ministry of Health, regions, municipalities and towns and other authorities, and it covered only about 12 thousand medical doctors, therefore the overall wage level shift in this sector in 2011 is not extremely significant. The year 2012 was absolutely the opposite for both sectors analysed, with the wage levels declining more strongly in the education sector than in the health care sector.

Since 2013, the wage level in both sectors has been rising more rapidly, with exception of a slight drop in median wage in the health care sector in 2013.

Figures 4–7 enable a comparison of the development of average wage in education and health care sectors with the development of average wage in two the best-paid sectors (sector of finance and insurance and sector of informatics and communications) and in two the worst-paid sectors (sector of accommodation activities and sector of administrative activities).

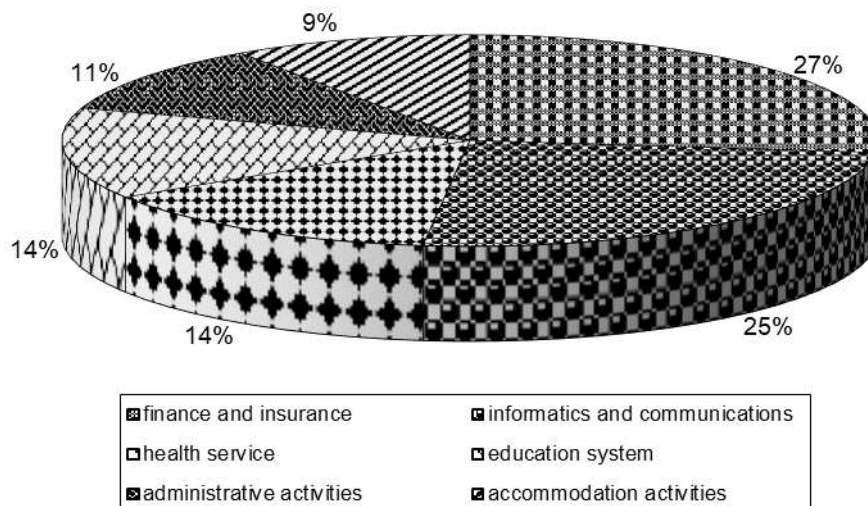
The values in Table 2, which represent the average annual growth rate of the average and median gross monthly wages in the period of global economic crisis (2009–2013), in the period past the global economic crisis (2013–2017), during the whole period of research (2009–2017) and supposed average annual growth rate of the average and median gross monthly wages in the period (2017–2020), are indicative of the conclusions in Fig. 2 and 3, too. We can observe only a slight average annual increase in wage levels during the world economic crisis, which is still mitigated by 2011 for both sectors. Only the average annual growth rate of the

average gross monthly wage in the education sector exceeds 1 %. In the period following the global economic crisis, the wage level is rising mainly in the health care sector, where average annual growth rates of both average and median gross monthly wages do not fall below 5 %. From the education sector's point of view, wage level growth is slower, and the annual growth rates of both average and median gross monthly wages do not fall below 3.5 %. We are cautious in terms of view of average annual wage growth rate for future three years in terms of both sectors analysed.

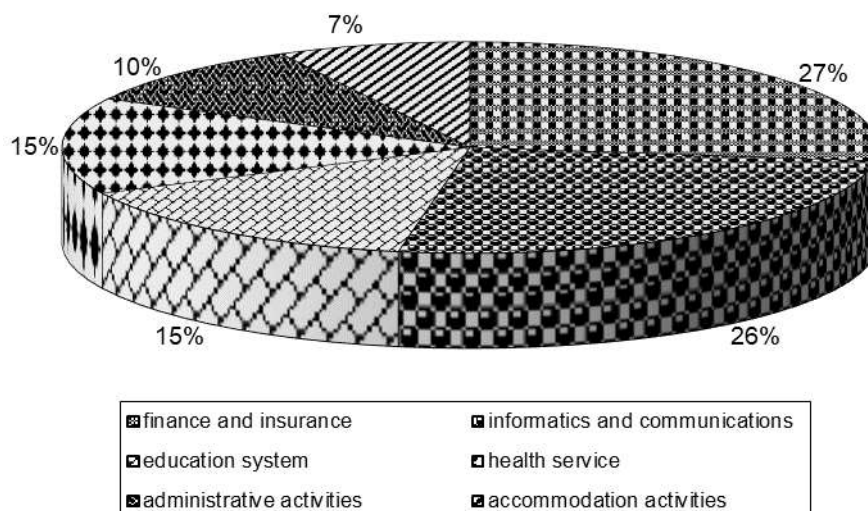


**Fig. 3.** Development growth rate of average and median wage (in percentages) in education and health care sectors.

Figure 8 provides a certain idea of the development of the absolute and relative variability characteristics in both sectors analysed, including the projected trend by 2020. It is clear from this figure that wages in the health care sector are much more variable than in the education sector in terms of both absolute variability and relative variability.

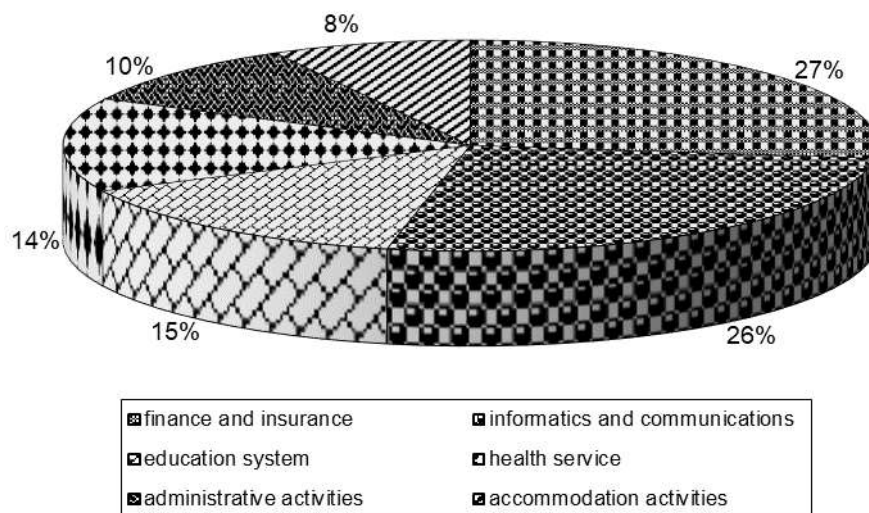


**Fig. 4.** Comparison of average wage in education and health care sectors with average wage in the best-paid and the worst-paid sectors in 2009.

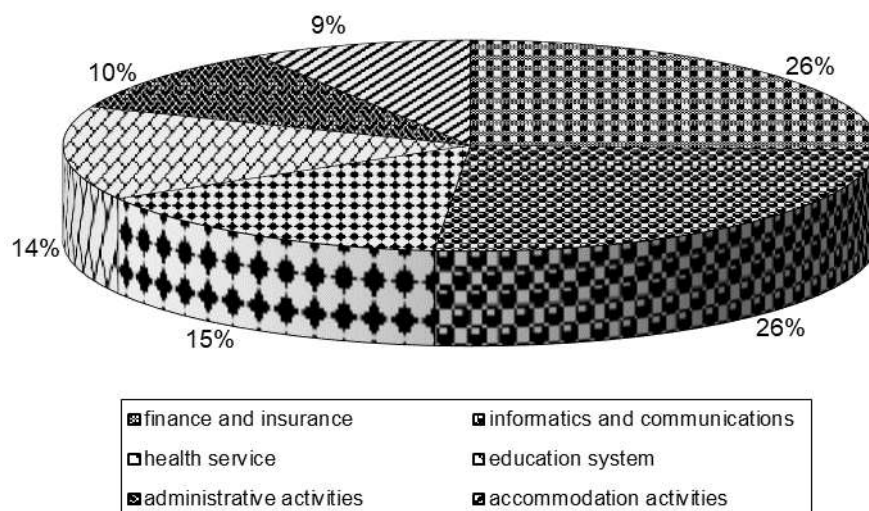


**Fig. 5.** Comparison of average wage in education and health care sectors with average wage in the best-paid and the worst-paid sectors in 2011.





**Fig. 6.** Comparison of average wage in education and health care sectors with average wage in the best-paid and the worst-paid sectors in 2014.



**Fig. 7.** Comparison of average wage in education and health care sectors with average wage in the best-paid and the worst-paid sectors in 2017.

**Table 2.** Average annual increase (in percentages) of the average and median gross monthly wage.

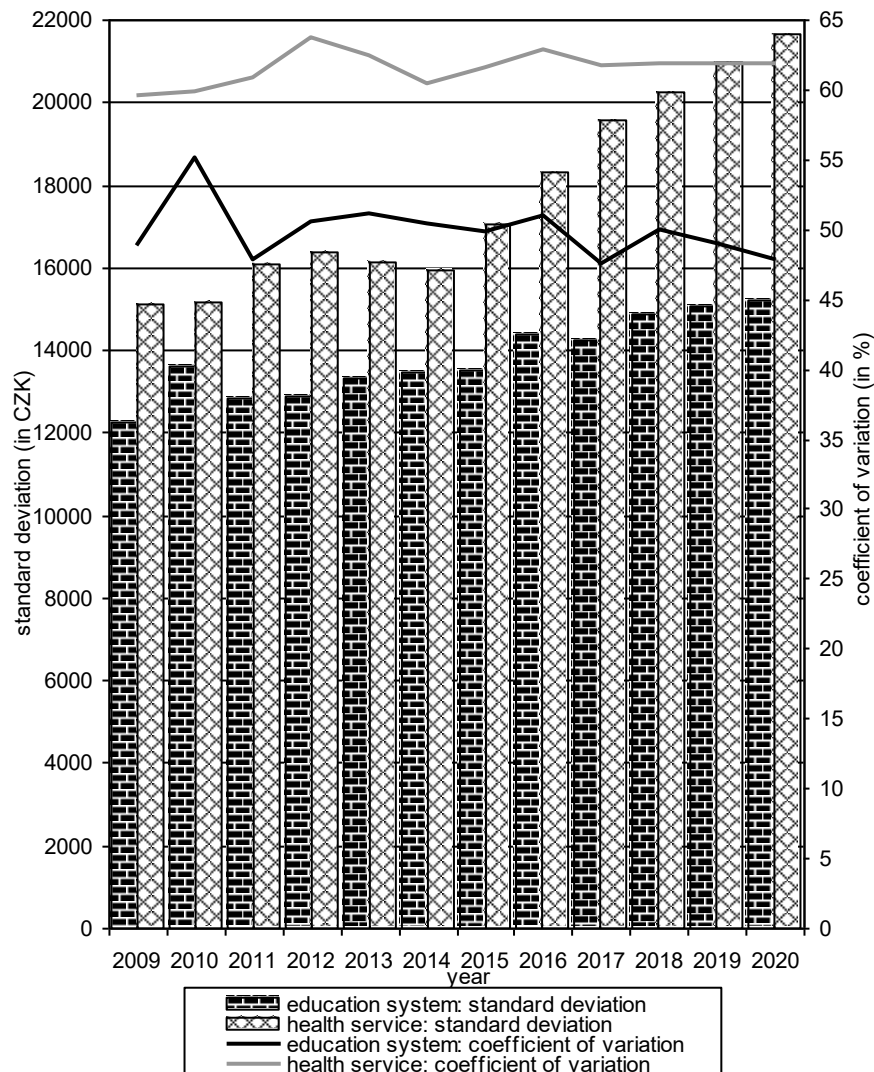
Period	Education sector		Health care sector	
	Average	Median	Average	Median
Ø 2009–2013	1.04	0.96	0.52	0.05
Ø 2013–2017	3.53	3.63	5.23	5.37
Ø 2009–2017	2.27	2.29	2.85	2.68
Ø 2017–2020	1.99	1.77	3.39	3.33

Wage standard deviation is a characteristic of absolute wage variability, and this represents the quadratic mean of all wage deviations of individual employees from their arithmetic wage mean. It therefore represents the extent to which wages of individual employees on average differ from their arithmetic mean. The characteristics of absolute wage variability tend to grow with wage level growth. This is reason, it is recommended to use the relative variability characteristics. The variation coefficient is a characteristic of the relative variability, and it is the ratio of the wage standard deviation and the arithmetic mean of wages. This determines, after multiplying by hundred, from what percentages the wage standard deviation participates in the wage arithmetic mean. The coefficient of variation is not defined for the case of the arithmetic mean equal to the zero, but the situation cannot be set in area of wages. Absolute wage variability has a growing tendency in terms of both sectors, which can be expected to be in line with wage level growth, while relative wage variability varies with both sectors analysed, see Fig. 8.

Figure 9 provides an idea of the development of wage diversification in both sectors under consideration, including projected developments until 2020.

The greater the value of Gini coefficient is closer to zero percent, the wage distribution of employees comes to be absolutely egalitarian, i.e. the value of the Gini coefficient equal to zero percent theoretically becomes at extreme nivelisation. The values of Gini coefficient close to 100 percent point out to a state of absolute inequality in employee wages, i.e. the value of the Gini coefficient equal to 100 percent theoretically occurs extreme diversification, where the whole wage belongs to one employee. However, the Gini coefficient values in the extremes of that interval are not achievable in the real world, because in the real world, individuals earning more on one side and individuals earning less on the other side will always exist.

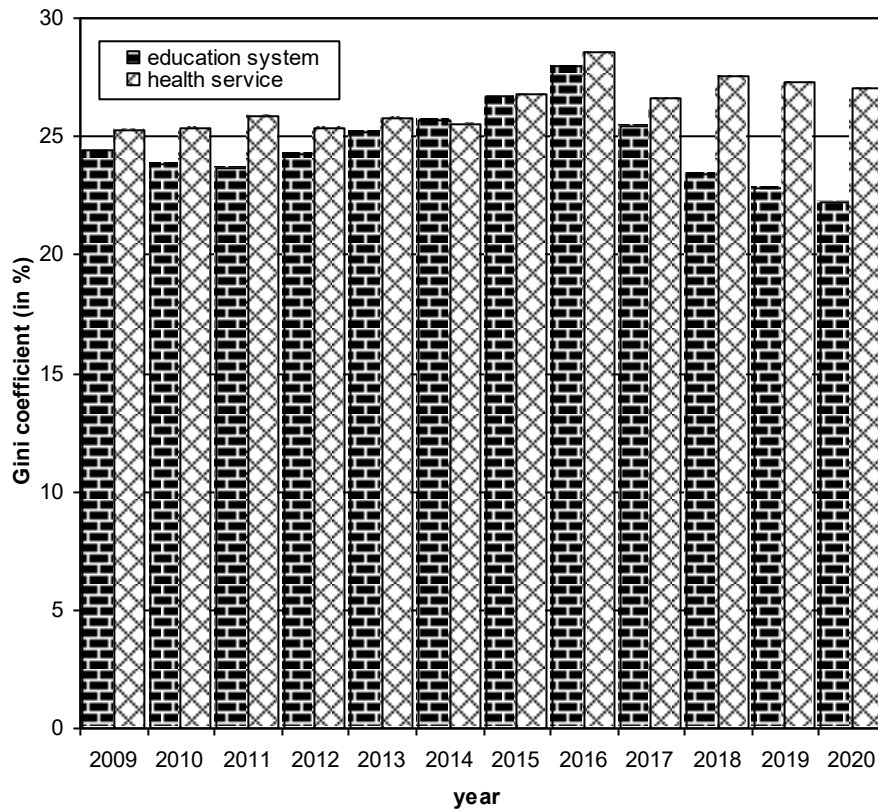
It is clear from Fig. 9 that wages in the health care sector are somewhat more diversified than in the education sector except of 2014. We expect significantly greater wage diversification in the health care sector than in the education sector with a decreasing trend in both sectors in the future.



**Fig. 8.** Development of characteristics of absolute and relative variability (standard deviation in CZK and coefficient of variation in percentages) of gross monthly wage in education and health care sectors, including predictions to 2020.

## 5 Conclusion

We can conclude that wages in the education and health care sectors are relatively similar. Wages in Czech education and health care sectors currently rise the fastest since the beginning of the global economic crisis, especially in the health care sector.



**Fig. 9.** Development of Gini coefficient (in percentages) of gross monthly wage in education and health care sectors, including predictions to 2020.

The average gross monthly wage in the health care sector grew by 8.96 % per year in 2017 and the median gross monthly wage even by 9.54 %. The average gross monthly wage in the education sector grew by 6.48 % per year in 2017 and the median gross monthly wage even by 6.60 %. The exception is only a certain leap in wage developments during the global economic crisis in 2011, which was more pronounced in the education sector than in the health care sector, which is mainly due to a significant increase in wages mainly for young teachers at the beginning of 2011. In the health care sector, there has been also a significant increase in the wages of medical doctors by almost of 15 % in 2011. However, this figure applies only to public health care and it covers approximately only 12 thousand medical doctors. Therefore, the overall increase in wage level in this sector is not extremely significant in 2011. When comparing the wage levels of the education and health care sectors with two the best-paid sectors and two the worst-paid sectors in the Czech economy, the median gross monthly wage in the education sector is higher than the median gross monthly wage in the health care sector throughout the monitored period. In terms of average wage, however, the situation is different and the average gross

monthly wage in the education sector is higher than the average gross monthly wage in the health care sector in 2011, when a significant increase in wages mainly for young teachers became, and in 2014, after the end of the global economic crisis. At the beginning of the global economic crisis and at the end of the monitored period, the average gross monthly wage in the education sector is lower than in the health care sector. Both the average and median gross monthly wages in the education and health care sectors are significantly lower compared with two the best-paid sectors in the Czech economy (finance and insurance sector and informatics and communications sector), while the difference from two the worst-paid sectors is not so remarkable.

For the future, it is necessary to attract young teachers to education sector so that they do not run out of this sector either right after graduating from the Faculty of Education or after starting a family due to lack of finances. The same can be said from the point of view of nurses. Young doctors usually do not come from their sector, but abroad. However, if they graduate for state money in the Czech Republic, they would be bound to work a certain number of years in the Czech health service or to return tuition fees.

**Acknowledgements.** This paper was subsidized by the funds of institutional support of a long-term conceptual advancement of science and research number IP400040 at the Faculty of Informatics and Statistics, University of Economics, Prague, Czech Republic.

## References

1. Český statistický úřad, <http://www.czso.cz>, last accessed 2018/11/21.
2. Falaris, E. M.: Private and public sector wages in Bulgaria. *Journal of Comparative Economics* 32(1), 56–72 (2004). DOI: 10.1016/j.jce.2003.09.010.
3. Chotikapanich, D.: *Modeling Income Distributions and Lorenz Curves*. 1st edn. Springer, New York (2008).
4. Larson, R., Farber, B.: *Elementary Statistics: Picturing the World*. 6th edn. Pearson Education Limited, Edinburgh Gate (2015).
5. Martins, P. S., Pereira, P. T.: Does education reduce wage inequality? Quantile regression evidence from 16 countries. *Labour Economics* 11(3), 355–371 (2004). DOI: 10.1016/j.labeco.2003.05.003.
6. Melly, B.: Public-private sector wage differentials in Germany: Evidence from quantile regression. *Empirical Economics* 30(2), 505–520 (2005), DOI: 10.1007/s00181-005-0251-y.
7. Panizza, U.: Public sector wages and bureaucratic quality: Evidence from Latin America. *Economía* 2(1), 97–151 (2001). DOI: 10.1353/eco.2001.0015.
8. Teal, F.: Real wages and the demand for skilled and unskilled male labour in Ghana's manufacturing sector: 1991–1995. *Journal of Development Economics* 61(2), 447–461 (2000). DOI: 10.1016/S0304-3878(00)00064-X.

# Optimization of Communication Principles in Multi-Agent Economic System

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**Abstract.** The paper is focused on the memory optimization for the communication mechanisms on markets (goods, services) in the agent-based computational economy – Virtual Economy Project (VEP). For the realization of the business, the facilitators such as matchmaker and broker are used. These agents allow effective distribution of goods and services and thus constitute a key component of supply chain management within the whole model. The design emphasizes the high adaptive potential of the entire trading system and the ongoing adaptation to changing environmental conditions. Mechanisms of indirect communication allow effective scaling of trading on markets of different sizes, it means that they are used for both - retail and wholesale transactions. The main focus is on the possibilities to optimization of the allocation memory for the used algorithms, their comparing and on the prediction for the future extension of the model. The paper is also focused on the description of the key features of the market mechanisms of the model, the description of the algorithms for the implementation of the business, arguments for their introduction in this form, and the description of the practical implementation of the facilitation agents in the AnyLogic 8 environment used for system development.

**Keywords:** Agent, Optimization, Broker, Agent-based Economic Model, Travel Market.

## 1 Introduction

Communication is a deliberate exchange of information in multi-agent systems that deliver the production and perception of brands that are drawn from a shared system [10]. Such a shared system can be understood as a language dictionary based on the multi-agent system, which describes standards and rules of communication among the agents.

Communication can be divided into two basic categories according to the aspects from which we can perceive it. If there is a communication principle between two agents where the message from the sender gets directly to the recipient, the communication is direct. On the other hand, if a third agent is used as a mediator, is needed to mediate communication - indirect communication [12].

One of the basic issues of multi-agent systems is the search for certain agents that have (or may have) information the initiating agent searches for [7]. The issue helps

to solve the facilitation agents, which appear in the system as already mentioned mediators. Within this text, attention will be focused primarily on the use of such facilitation agents for the realization of the functioning of the goods and services markets in the environment of the agent-oriented computational economy.

## **2 Coordination of Agents Through Mediators**

In a highly dynamic, competitive and comprehensive environment of goods and services markets, consumer decision-making depends on several individual factors. It can be a network of contacts, innate consumer dynamics, or various external environmental influences [8]. Similarly, it can be considered for non-end consumers - companies, factories, etc. However, this approach assumes that all agents have their own dynamic database that contains accurate information about other agents (location, services provided ...) and which is continuously updated during the system run.

However, the maintaining such a database is very impractical for large multi-agent systems (MAS) - it leads to increased computational difficulty, updating of individual agent databases, or more complex definitions of agent behavior (all types that we assume to be on the goods and services market) unreasonably high computational demands [9].

The mediating agents (mediators) do not contribute directly to addressing the desired goal, but they support the flow of information in the MAS community [14]. At the same time, they enable the distribution of the communication load to logical units or sets of agents according to regional, type, or other competencies. Thanks to their knowledge, which contains the necessary information about all the agents in the system (or a sufficiently large subset of them) [6], they can find agents who are able to meet the target.

## **3 Virtual Economy Project**

The VEP (Virtual Economy Project) is largely oriented to effective distribution of all types of products, which are used in the model. There are applied some principles of indirect communication or principles of offer and demand [13].

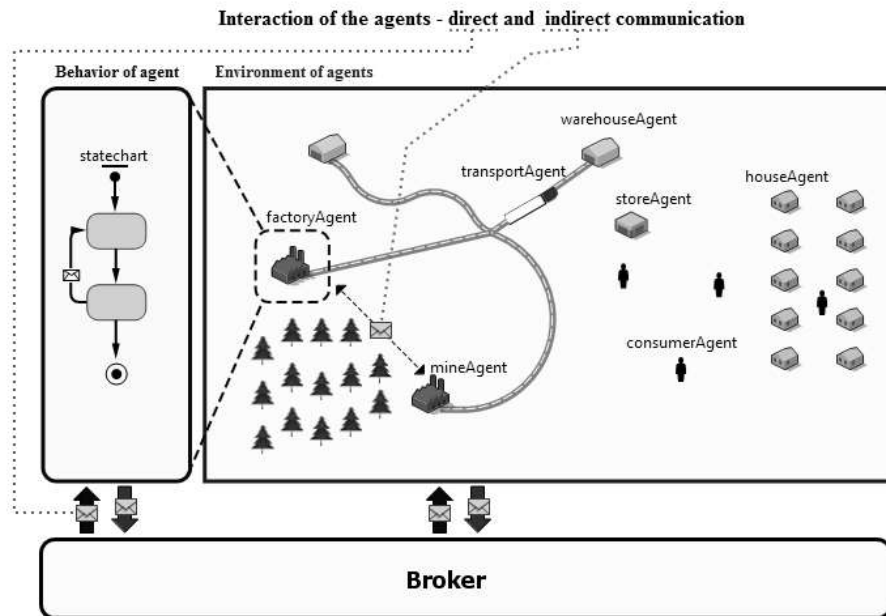
Multi-agent model AVE is developed by Anylogic tool (actual version 8.2.). Anylogic is a development environment which runs on the JAVA platform [14]. The platform allows to use three basic approaches to modeling systems [12]:

- Agent-based approach,
- Discrete event,
- System dynamics.

All of these ways are mutually combinable, so it is possible to use all of them in one project [2].

As an example, the behavior of a factory agent (a factory-oriented agent (manufacturing company) - FA) can be mentioned. FA can use behavioral charts

to define behavior that includes communication with facilitators, and system dynamics as well as the process itself.



**Fig. 1.** Graphic representation of the agent interactions [2].

AnyLogic also enables the development of visually rich interactive environments with a simple yet sophisticated animation function [2]. In the figure (see Fig. 1), there is a simplified indication of how the MAS graphic environment can look like, how the agent's behavior can be defined, and what kind of communication between agents is already used in VEP [5].

### 3.1 Principles of the Markets in AVE

The retail markets serve to distribute products for both end-users (consumer-type agents, CA) and for endless consumers – factories (FA), shops (SA), service providers (transport agents - TA). Retail and wholesale levels are distinguished [1].

The retail market is focused on satisfying the needs of the consumption of end customers, i.e. CA, which in the AVE model represent human individuals. Within the retail market, they constitute an offer of Store agents (Business Agents, SA). These SAs receive FA goods in standardized contracts (in the VEP context in standardized batches, e.g. the volume of goods that the lorry takes) at wholesale goods market. Conversely, they convert from a wholesale format to a retail consumer market format.

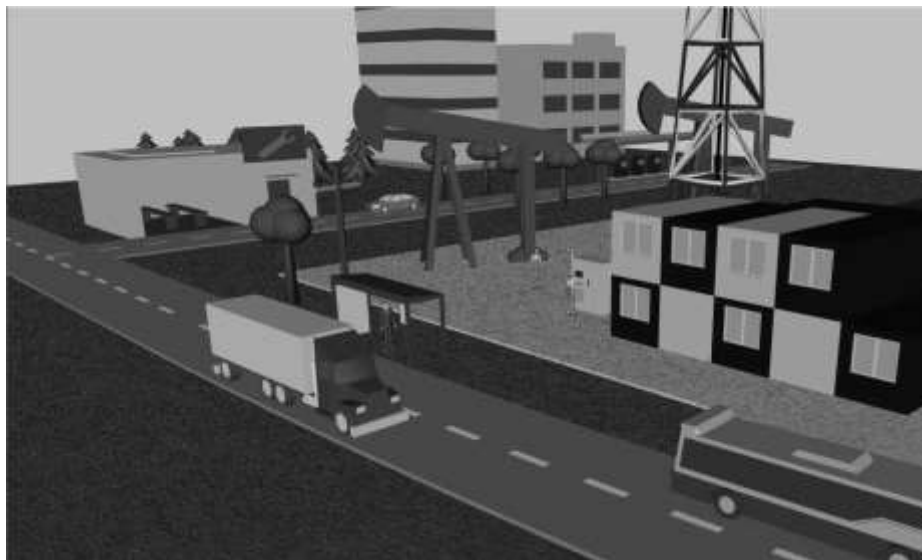
Some FAs also enter this market in the form of a seller, despite the fact that they do not have a comparatively wide range of goods compared to SAs that could offer. Nevertheless, they can have a significant share of the retail goods market due to lower



prices for selected products. SAs usually have a higher price due to import charges, marketing costs, and mediation gains and other similar factors.

Compared to the retail market, the wholesale market is primarily focused on non-end customers, primarily FA, which represent the production companies in the model. FAs need certain inputs - energy, labor, and in particular the material needed for production, which they derive from the wholesale commodity market. They distribute their merchandise to Mine Agents (mining agents, they do not need input materials, MA), and several FA ones.

But FAs are the main buyers. Their goal is to produce a certain kind of goods, which is then trying to sell as much as possible. Each FAs has a production chain in which it is defined what components the product consists of, and also in what proportion one the individual components are represented by for a given time period (e.g., day or shift).



**Fig. 2.** Representation of the 3D scene in Anylogic [2].

The next type of the markets in the VEP is service market. The market is specific from the previous types because there are variety of types of services – labor, travel, cosmetic, car etc. The labor services are the most important in the VEP that the separate market has been implemented [4].

### **3.2 Implementation of the Communication in the VEP project**

The first phase of verification of the functionality of the model was carried out by ensuring the basic cycle of raw materials and goods in the model, especially among the FAs, who would not be able to realize the production without the required inputs. For the initial verification, whether the theory of raw material flow from MA to FAs will work properly (or whether functional status diagrams for defining FA behavior

were created), several transport agents (TA) were created to fill a warehouse at MA to convert the corresponding amount to the FA that these raw materials require.

Once this method was found to be functional, it was already possible to model the communication itself, where agents could follow a standardized system orders (requirements) and bring the project closer to the realistic principles of the economic market.

Direct communication in the VEP. At the beginning of the project development, there were about 250 instances of the agents. The communication was implemented as a standard procedure where all market participants can communicate with all others to accomplish their own goals [4].

This approach was realized by implementing the complex behavior of each type of agent. There are some parts of the behavior of each agent type:

- Communication protocols with different agent type - different types of agents have different messages that they can respond. Due to this fact, several new communication functionalities of agents were implemented.
- Database of the other agents – agents need to know about the others. It is necessary to determine which agent could help to reach the actual goal (i.e. SAs can sell the food products to satisfy the CA need).
- Comparing mechanisms of the offers (product, raw material, transport offer...). Every agent wants to reach its goal in the most appropriate way. On the retail market of goods it is i.e. the lowest price for the required product, but in the large scale – with calculating with the travel costs due to the location of the shop and the agent location (house).

In a short run of the simulation (about three months of the simulation time) the simulation ran fluently and the behavior of the whole system worked correctly – the Mine agents mined the raw material (coal, iron ore, corn, grain, meat...), distributed their products on the wholesale market database by themselves where the Factory agents bought raw materials, produced the products which have been distributed on the wholesale market database, where the products have been bought by Store agents, then distributed on the retail market database and bought by Consumer agents...

In a long run of the simulation (from three months up to two years of the simulation time) the simulation was not run in fluent and several of the computations were not finished correctly. The issue was caused by insufficient system performance. There was a high load of the memory and high CPU usage. The performance issue was caused by a large amount of data of the market and agents databases.

All agents used the own databases and the market databases to find the best product for the satisfying their needs. But with the increased data in this databases, the processing algorithm of each of the agent took much longer time than usual and required more memory allocation. In some cases, the free memory was not available and several processes fail.

Within the scalability of the project where the rapid increase of the agents was expected in the final version (more than 100 000), the solution for this issue was proposed - implementation of the indirect communication among the agents.

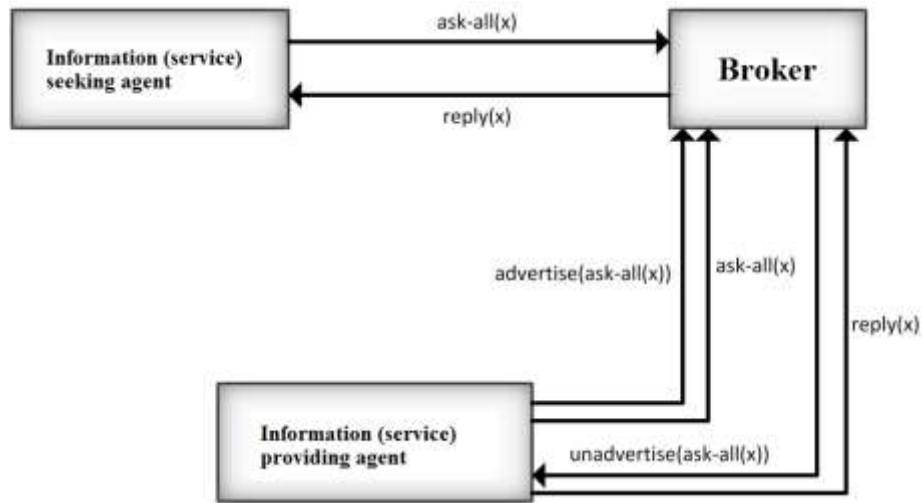
**Indirect communication in the VEP – Broker agent.** For the intermediary of indirect communication on the commodity market, a broker agent (broker) was chosen whose operation will be described in detail below.

In general, a broker is an agent that maintains a database of other agents in the system and tries to mediate their request to meet the desired goal. Such a process involves three basic agent roles [7]:

- Applicant - an agent whose goal can be achieved only by another agent,
- Broker – mediator agent,
- The server of the Broker - broker database (can be also an agent).

In our case, the applicant may be an FA (or CA), the broker here is an intermediary that intermediates the chain of steps to be taken to achieve the desired goal, and the broker database can be i.e. classic database (MySQL), an Excel workbook data or special agent. An Excel workbook was used in the first versions of the VEP as a local database but from the Anylogic 8.0 is for the current version used integrated MySQL server within the optimization of the large data processing.

In the model, the broker represents the intermediary between the buyer and the seller in the wholesale/retail market of goods. It handles orders, distributes goods to the market, and mediates product transport from the provider to the client.



**Fig. 3.** Broker principle and operations [4].

The broker allows agents to request mediation of the planned deal to reach the agent's goal. Such an agent does not maintain a database of other agent information, he knows only the address of the broker he can contact to satisfy any of his needs (i.e. product distribution, product purchase).

This leads to a significant reduction of the communication flow and higher efficiency of communication. With a higher number of agents in the model (thousands), when

the communication would be enabled among each other, the execution would be extremely demanding for CPU and memory.

To create a more effective indirect communication across product ordering, the Order class was created to define all the necessary ordering features that are important to the broker. The Order class contains a unique identifier for the client (idClient), whereby the broker determines who is the client of the order, the product that the client requests/distributes and the amount. The Broker from this information can calculate the final price which the client is willing to pay.

The Broker has implemented methods to (a) finding other agents to communicate with, (b) finding the most available products in the required amount on the market, (c) recalculating prices on the market (discount before the expiration – usable for the Store agents), (d) updating market databases about new products or sold products, (e) optimize database table (archiving of the records to free up the memory and to optimize finding processes).

These Broker's functions are on the one location in the memory and the behavior of the other agents is much simpler than with the direct communication [3]. With this implementation, the simulation run was more efficient than before. Now, the simulation run fluently for the more than 5 years of the simulation run.

In the latest version of the VEP, the new functionality to optimize the communication was added. Now there are several Broker agents available in the simulation in-stead of one – always one City Broker is implemented per City and one main Broker for communication between City Brokers. It was due to constantly expanding virtual economy environment (from city to district, district to state...).

#### **Overview of the potential memory saves by indirect communication approach.**

The indirect communication approach is used within the consumer's finding algorithm where the appropriate service providers are searched. For the potential memory saves overview the procedures from [11] were used. The implemented algorithm is described in Fig. 4.

**Table 1.** Objects and agents used in the provider finding a cycle.

<b>Object/Agent</b>	<b>Number of occurrences</b>	<b>Memory allocation shortcut (1 unit)</b>
Consumer	Nc	Mc
Provider	Np	Mp
Broker	0...1	Mb
List	1...N	MI

During the executing of the algorithm, several objects will be processed. The objects and agents will require the relevant allocation of the memory. The over-view of the objects and agents used in service-provider finding algorithm is described in the Table 1.

The total memory usage for the all consumers (TMc) and providers (TMp) will be always allocated by the simple formulas:

$$TMc = Mc * Nc \quad (1)$$

$$TMp = Mp * Np \quad (2)$$

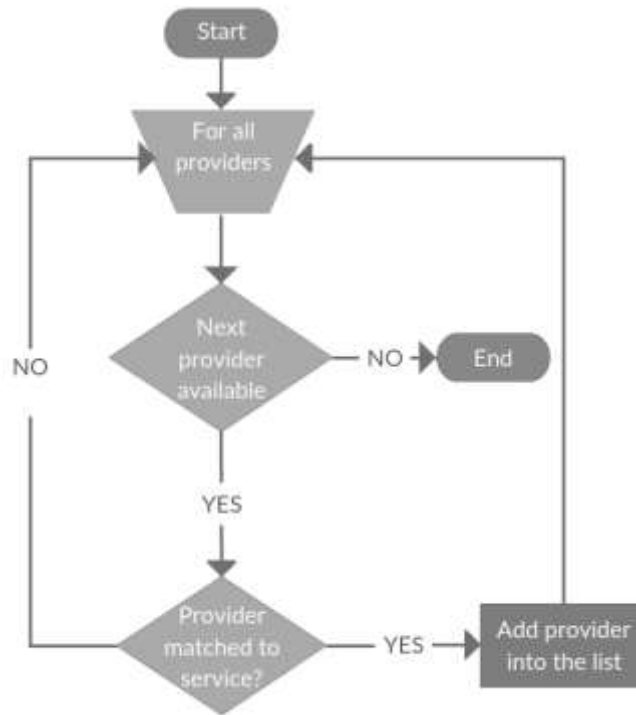
In the principle of the direct communication, every consumer agent has to contain the List object for the found providers. The final formula for the memory usage  $O(n)$  in this algorithm will be:

$$O(n) = TMc + TMp + Nc * Ml \quad (3)$$

A full algorithm with the better-displayed dependency of the inputs (number of consumers) for total memory usage:

$$O(n) = Nc * (Mc + Ml) + Np * Mp \quad (4)$$

which is the final formula for the total memory usage for all consumers and providers with total memory usage for the all consumer's lists.



**Fig. 4.** Diagram of the finding provider algorithm.

In the indirect communication usage, only the Broker agent (which is not implemented in the direct communication approach) contains the List of the providers. The final formula for the memory usage in this algorithm is:

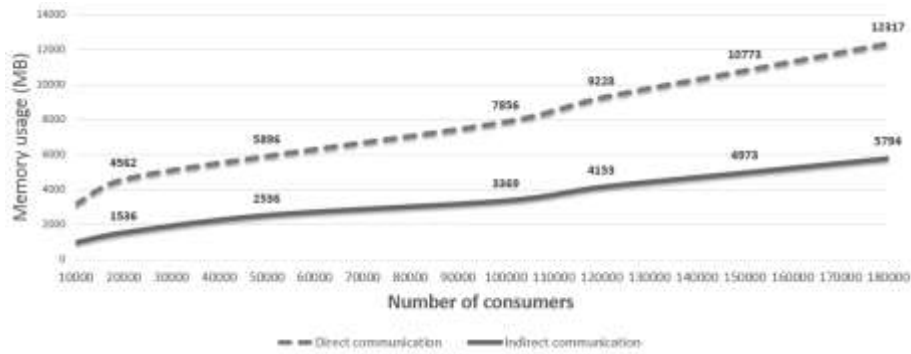
$$O(n) = TMc + TMp + Mb + Ml \quad (5)$$

A full algorithm with the better-displayed dependency of the inputs (number of consumers) for total memory usage:

$$O(n) = Nc * Mc + Np * Ml + Mb + Ml \quad (6)$$

which is the final formula for the total memory usage for all consumers and providers with memory usage for one Broker agent with one list. The predicted formulas can be compared with the measured values.

**Real usage of the memory with different communication approaches.** For the verification of the optimization the memory usage analysis, the simulation runs with the identical settings were provided for both project implementation - direct and indirect communication approaches.



**Fig. 5.** Comparison of the communication approaches.

In the application the consumers searched for the providers of the tourism services. There were different kinds of the services – based on the locations, prices and capacity. The comparison results are shown in the Fig. 5.

The simulations ran for both approaches for **10 times** (20 in total). The start value of the consumers was **10 000**. After each run (experiment gathers the data for the **100** simulation days) the number of the consumer agents was increased about the next **10 000**.

As it is shown on the graph the simulation ran on the old VEP project version - with the direct communication approach – the memory usage was almost three times higher than on the newer version of the application with indirect communication approach. For example, for the **10 000** of the consumer agents the usage of the memory was **4562** MB for direct communication and **1536** MB for indirect. For the **180 000** of the consumer agents was the memory usage **12317** MB for direct and **5794** MB for indirect.

Compared with the predicted formulas the results reflect the linear function. If we consider that the number of consumer agents is the only value which could be changed (other parameters are constants):

$$O(n) = Nc * (Mc + Ml) + Np * Mp \quad (7)$$

$$O(n) = Nc * (CONST\_1 + CONST\_2) + (CONST\_3 * CONST\_4) \quad (8)$$

$$O(n) = Nc * CONST\_12 + CONST\_34 \quad (9)$$

the formulas for the direct communication can be recorded as a classic linear function formula  $y = ax + b$ .

The same principle could be applied to the indirect communication formula:

$$O(n) = Nc * Mc + Np * Mp + Mb + Ml \quad (10)$$

$$O(n) = Nc * CONST\_5 + (CONST\_6 * CONST\_7) + (CONST\_8 + CONST\_9) \quad (11)$$

$$O(n) = Nc * CONST\_5 + (CONST\_67 + CONST\_89) \quad (12)$$

$$O(n) = a * x + b \quad (13)$$

where  $O(n)$  is total allocated memory:  $y = ax + b$ .

The real formula from the measured data results was determined by the statistic functions in the **R** program. For the direct communication the formula was determined as follows:

$$y = 0.0509x + 3102.7 \quad (14)$$

and for the indirect communication:

$$y = 0.027 + 900.94 \quad (15)$$

The results correspond with the predicted formulas – the direct communication has the higher constant value than indirect ( $Mc + Ml$  instead of only  $Mc$ ) and smaller  $b$  constant value than indirect (only  $Np * Mp$  instead of  $Np * Mp + Mb + Ml$ ). The linear increase of the memory was proved for both approaches.

## 4 Conclusion

The optimization of the memory and CPU usage is very important part of the continuously extended multi-agent systems. Within the increasing of the number of the agents and more complex behavior of the agents in the environment, the simulation run needs more HW performance. This could be solved by sequential updating of the HW - better CPU, more memory etc., but the price will be high.

The other solution is to optimize the processes in the model. In this paper, the optimization of the model simulation was implemented by changing the communication approach from the direct communication, when all agents need to be informed about the others and the behavior of this agents had to be more complex, to indirect.

Within the indirect communication, the complex algorithms are only in the facilitation agent Broker which was responsible for the providing of the whole request of the other agents.

The optimization was verified by the comparing of the memory usage across the simulation runs on both communication approaches.

**Acknowledgements.** This work was supported by the FIM UHK under Grant of Specific Research Project “Information and knowledge management and cognitive science in tourism”.

## References

1. Algarvio, H., Lopes, F., Santana J.: Multi-agent retail energy markets: bilateral contracting and coalitions of end-use customers. 12th International Conference on the European Energy Market (EEM), pp. 1-5, IEEE, Lisbon (2015).
2. ANYLOGIC Homepage, <http://www.anylogic.com>, last accessed 2018/05/27.
3. Baert, Q., Caron, A., Morge, M., Routier, J.: Fair multi-agent task allocation for large datasets analysis. Knowledge and Information Systems, vol. 55, pp. 591–615, Springer, London (2017).
4. Blecha, P.: Labor Market In Multi-Agent Environment Modeling Virtual Economy. In: Hradec Economic Days, vol. 8, pp. 114–120, Hradec Kralove (2018).
5. Bures V., Blecha P., Tucnik P.: Agent-Based Modelling and Simulations as an Integral Functionality of the Business Intelligence Framework. In: Dregvaite G., Damasevicius R. (eds) Information and Software Technologies. Communications in Computer and Information Science, vol. 538, pp. 236–245, Springer, Druskininkai (2015).
6. Byrski, A., Drezewski, R., Siwik, L., Kisiel-Dorohinicki, M.: Evolutionary multi-agent systems. The Knowledge Engineering Review, pp. 171–186, Cambridge University Press (2015).
7. Decker, K., Williamson, M., Sycara, K.: Matchmaking and brokering. In: Proceedings of the Second International Conference on Multi-Agent Systems, ICMAS-96, vol. 432. (1996).
8. Garifullin, M., Borshchev, A., Popkov, T.: Using AnyLogic and agent-based approach to model consumer market. In: Proceedings of the 6th EU ROSIM Congress on Modelling and Simulation, pp. 1–5. (2007).
9. Parker, J.: Coordination in large scale multi-agent systems for complex environments. In: Proceedings of the 2014 international conference on Autonomous agents and multi-agent systems, pp. 1751–1752 International Foundation for Autonomous Agents and Multi-agent Systems, Paris (2014).
10. Russell, S. J., Norvig, P.: Artificial intelligence: a modern approach. Pearson Education Limited, Malaysia (2016).
11. Sipser, M.: Introduction to the Theory of Computation. Course Technology, 2nd edition, (2005).
12. Spiro, R. J., Bertram C. B., Brewer, W. F.: Theoretical issues in reading comprehension: Perspectives from cognitive psychology, linguistics, artificial intelligence and education. vol. 11. Routledge (2017).



13. Tucnik, P., Blecha, P., Kovarnik, J.: Adaptation to Market Development Through Price Setting Strategies in Agent-Based Artificial Economic Model, vol. 10448, pp. 548–557, ICCCI, Cyprus (2017).
14. Wagner, T., Rana, O.: Infrastructure for agents, multi-agent systems, and scalable multi-agent systems. In: International Workshop on Infrastructure for Scalable Multi-Agent Systems, Barcelona, pp. 3–7, Spain (2001).

## Gamification as an Innovative Idea within Human Resources Management

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**Abstract.** The purpose of the article is to present gamification as an innovative instrument used in Human Resources Management (HRM). Gamification fits into the concept of the Industrial Revolution 4.0 (also referred to as the Cyber Revolution). Due to a lack of statistics on the use of gamification in HRM, the article presents the character of the analyzed concept, the areas where gamification is used and underlines directions for further research. The paper is based on subject literature studies in combination with scientific reflection. The paper discusses both global changes and the nature of Polish HRM.

**Keywords:** Modern Technologies, Gamification, Human Resources Management

### 1 Introduction

Managing people (human resources management, HRM) can be considered the key management area. Individuals and groups have the most influence on achieving goals thanks to their competences (knowledge and skills) and motivation. HRM includes actions which are focused on recruiting and retaining valuable employees. In the literature we can find many different definitions and scopes of HRM. It is generally assumed that a set of actions or areas of HRM consist of recruiting and selecting (R&S), onboarding, training, evaluating, rewarding and HR flow (including career management). Approaching HRM from a broader perspective such topics as working conditions (including health and safety) and the formation of organizational culture are considered. The term which consolidates many of the above-mentioned actions is motivating people.

Nowadays, job market is very turbulent, which is a challenge for employers. In order to find and maintain high-quality human potential a company has to adjust to the needs and expectations of potential and existing employees. In the current job market two generations of employees dominate (Generations X and Y). The latter generation (as well as the next one who are now still “cutting their teeth”) is called the companies’ future. A Gallup study shows that they are the least engaged generation, with only 28.9% engaged, as compared to 32.9% for Generation X [20]. In the literature many

characteristics of Generation Y are presented. It is said that Millennials commit themselves to activities which provide them with personal fulfilment and that they desire to shape their own development. Moreover, they believe they are a part of “global village” thanks to unlimited Internet access. People from Generation Y are fluent in modern technologies. There is also the following generation – known as WWW or C – who actively influence the content of commonly accessed Internet sites. Members of the last two generations have spent much time in front of a computer working, learning, socializing, shopping and having fun. Entertainment as well as education is delivered through playing computer games.

J. Huizing defines a game as a voluntary activity which we consciously treat as less serious than everyday life, but which at the same time completely engrosses the player. This activity is not associated with material gains. A game is played in its own space, place and time, according to established rules and in a set order [33]. Some people believe that games have always existed, “from the first Olympics in ancient Greece through “The Biggest Loser” television show to the latest Xbox offering” [30]. But the first computer games appeared in the 1940s [38]. Modern solutions are more and more technologically advanced and interactive and computer graphics are 100% realistic. The old and new games have one trait in common: the computer game players display their determination, persistence and engagement. It was assumed that the players’ drive could be transferred to the real world and utilized in finding solutions to real problems – in the workplace as well. In this way gamification is becoming a new trend in management and marketing [28]. It uses game mechanics to modify people’s behavior – including employees.

Gamification fits into the concept of the Industrial Revolution 4.0 (also referred to as the Cyber Revolution). The use of new technologies exerts an impact on people’s attitudes and HRM processes (for more see [26]). There are some concepts matching HRM with this Industrial Revolution, e.g., the concept of e-HRM and HRM 4.0. E-HRM is defined as “the way of implementing HR strategies, policies and practices in organizations through a conscious and directed support of and/or with the full use of web-technology-based channels” [31]. In turn, adding the number “4.0” to the term of HRM means the digitalization of all HR processes [35]. We can call gamification the newest innovative instrument of HRM and, in the same way, create a concept of gamified HRM.

The purpose of this paper is to present the idea of gamification in the context of HRM. The problem was discussed in more detail by means of answering the following research questions:

- What is the character of gamification? How does it work?
- In which areas of HRM is gamification used?
- What are the directions for research in the topic of gamification in HRM?

In order to provide answers to the above research questions literature studies were conducted in combination with scientific reflection. Due to a lack of statistics on the use of gamification in HRM, the article will present some examples of gamification which we can find in the academic literature and on websites dedicated to HRM and

technology issues. The paper discusses both global changes and the nature of Polish HRM. The paper also indicates directions for empirical research in the area of gamification. That is why it can be treated as a pilot paper for future research.

## 2 Methodology

The main research method which was used for the purpose of this article is literature studies. The author used a stand-alone review in order to provide an overview and synthesis. A review of subject literature was carried out by analyzing the Web of Science database. The keyword “gamification” in combination with “HRM” was used. Then the author read all the articles in order to check whether they really focus on a topic similar to the one presented in this article. The focus was put on academic papers (in Polish and English) that have been published in the last seven years (2011-2018). The results of the database search are presented below.

**Table 1.** Publications about gamification indexed in Web of Science in the last eight years.

Year of publication		2011	2012	2013	2014
Number of publications (conference proceedings and articles) indexed in Web of science	Results for the keyword "gamification" in the topic	5	35	100	239
	Results for the keyword "gamification" in the title	2	17	45	119
	Results for the keywords "gamification" and "HRM" in the topic	0	0	0	0
Year of publication		2015	2016	2017	2018
Number of publications (conference proceedings and articles) indexed in Web of science	Results for the keyword "gamification" in the topic	493	718	662	259
	Results for the keyword "gamification" in the title	200	315	265	99
	Results for the keywords "gamification" and "HRM" in the topic	0	0	1	0

The main conclusion after the database analysis is that gamification in HRM does not represent a highly popular topic in the high impact factor academic journals. That is why the authors decided to use also the Google search engine in order to find more information about the utilization of gamification in HRM. The conducted study shows mainly different case studies. None of the articles pertain to quantitative research in the area of gamification used in HRM.

### 3 Results of Literature Studies on Gamification in HRM

#### 3.1 General Characteristics of Gamification

The term “*gamification*” was “coined in 2002 by the British consultant N. Pelling, as a “deliberately ugly word” to describe the application of a game-like accelerated user interface design in order to make electronic transactions both enjoyable and fast [3]. Nowadays, gamification is defined as utilization of game mechanics in order to increase the participants’ engagement. Gamification is also described as the “intersection of psychology and technology” [6]. Entertainment, clear rules, game design and challenges are connected with the use of games for achieving real world aims, not only for fun. In business it refers to implementing games in different organizational areas. This is possible thanks to combining business thinking with creativity and programmers’ tools [22].

As mentioned above, gamification is utilizing game elements (mechanics) and the rules of game design in order to solve problems, which are not actually games. In publications about gamification the concept of a “serious game” can be found. This concept “is more tightly concerned with the use of games to achieve serious outcomes” [40]. Gamification is not necessarily based on serious games.

The basic elements of game mechanics connected with game dynamics are as follows [41]:

- scores which are a kind of prize for making progress and completing tasks with feedback, which enable the immediate reaction of other players. In order to make a game more attractive these scores can be given an original name, based on the name of the company, its products, game topic, etc.
- levels which mark the status of the player and show the player’s position in rankings,
- scoreboards,
- trophies,
- challenges.

The phenomenon of gamification depends on providing players with positive emotions connected with what is known as state of flow. This state is when people are so involved in an activity that nothing else matters. The experience itself is so enjoyable that people will do it even at great costs, for the sheer sake of doing it [4].

In order for gamification to be beneficial, an organization should define the business outcome and success metrics. The second step is to define the target audience. The third step is to define the player goals. The fourth step is to determine the player engagement model. The fifth step is to structure the experience. Finally, the organization should be able to read the data obtained through gamification [3]. Moreover, the following factors are important [18,33]:

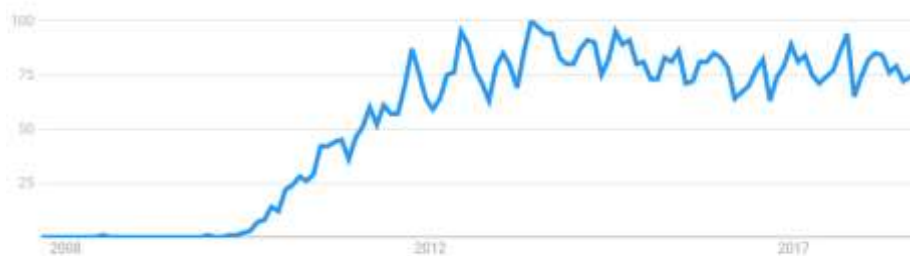
- clearly defined goals and conditions for winning,
- fair rules for all players,
- plot twists, adventures and challenges,
- voluntary participation,

- a way to communicate within the game.

Computer game mechanics have started to be used by many global organizations. The development of gamification is visible in different business areas, e. g rewarding clients for loyalty and encouraging them to design new products. Interest in this concept is growing more and more, not only in marketing, but also in human resources management [19].

While analyzing the definition of gamification one gets the impression that it is nothing revolutionary or innovative. That is why one may wonder why game elements were not implemented before in different areas of everyday life. The answer is simple – humanity did not have enough technology at their disposal or the use of technology was too expensive. Once Internet access, smartphones and tablets became widespread, interest in gamification started to increase.

According to a report by Gartner, by the end of 2020 70% of medium and large enterprises will have implemented at least one application based on gamification [10]. The global gamification market is grown rapidly. In 2013 the value of this market was 50M dollars, and the predicted value according to M2 Research will be as much as 5.5B dollars in 2018. This equates to elevenfold increase within five years [5]. In turn, the experts from Markets & Markets predict that by 2020 this market will reach the value of 11B dollars [16]. Figure 1 presents a Google trend graph to see how the interest in gamification has grown since 2008. The interest in gamification issues is also noticeable in academic papers (see Tab. 1).



**Fig. 1.** Interest in gamification over time according to Google.

In Poland, the high cost of Internet access and mobile devices is a reason why gamification is not as popular as in Western countries [13]. One more factor which was mentioned in the introduction is societal changes. A thesis can be formulated that as a result of the socialist system that was in place during the '80s, societal changes occur more slowly in Poland than in the West.

Taking into account the above considerations one can ask whether gamification has a place only in the virtual world. This is of course not true. Gamification, on the one hand, uses the mechanics of computer games. On the other hand, detailed tasks formulated in a game can be completed in reality. That is why gamification can be implemented in any team of employees – even in those who don't work in front of a

computer. The employer can also provide their employees with a mobile version of the game. According to a report by TNS Polska “smarphonization” in Poland (defined as the percentage of Poles using smartphones) was 58% in May 2015 [34].

It is worth mentioning that the use of gamification reduces costs in the long term. The cost reduction is connected with the possibility of adjusting a game to current needs and using it at different stages of the employee life cycle. It is not necessary to use only *on-line* platforms, because *off-line* games can be played as well. This enables the introduction of gamification into smaller enterprises. In order to use games in a company, a huge budget is not required. The most important factor is the willingness to be innovative [39].

### **3.2 The Areas of Using Gamification in HRM**

As results from Table 1, gamification in HRM does not represent a highly popular topic in academic research. The conducted study shows mainly different case studies of gamification implementation. Gamification is mainly used in such areas of HRM as recruitment and selection, onboarding, training, broadly defined motivating people and the formation of organizational culture.

The recruitment and selection of candidates is the first area of HRM in which the trends related to the fourth Industrial Revolution have been noticeable for a long time. The subject literature presents several types of recruitment referring to ongoing technological changes, i.e., the traditional one (prior to the 1990s), e-recruitment (1990-2005), social recruitment (2005-2015) and gamified recruitment (since 2015) [24]. Modern recruitment tools facilitate the creation of a modern employer image.

Within the area of recruitment, gamification can portray different aspects of the recruiting organization to potential applicants by immersing them in the organization or persuading them to apply for accept a job offer. Game-like assessments can be utilized within selection systems to identify the best applicants for the job. This solution was used by the Marriott hotel chain. The game developed specifically for its needs – “My Marriott Hotel” – presents working conditions in hotels and the players have an opportunity to test themselves by playing various roles and performing different professional tasks. It is important, however, that at any time during the game, the participant has an opportunity to become a part of the actual recruitment process by using the “Do it for Real” option and entering the hotel chain website, which presents current job offers and questionnaires to be completed [14].

Examples of interesting uses of gamification in the recruitment process can also be found in Poland [37]. The company Talent Bridge has developed a recruitment game which can be customized and adapted to an individual organization’s culture by tailoring the possible scenarios to an employer’s needs. One of the goals of this game is to recruit candidates for work. Their task consists of a virtual walk through a designed office in the course of which they are supposed to provide answers to questions about their education and experience, and to fill in recruitment forms [32].

The above examples indicate that the implementation of game-specific mechanisms can contribute towards increased efficiency of recruitment processes, measured

primarily by the number and quality of applications and their acquisition cost, along with a shorter recruitment process [8].

Gamification can also dramatically increase onboarding efficiency as candidates are motivated to complete various steps in order to earn rewards. Gamified training can challenge new hires to learn more during training, benefitting both the employee and the organization in the long term. The onboarding process is strictly connected with employee education. According to a study conducted by the University of Colorado on the impact of simulations and games in adult learners, the participants in gamified eLearning experiences scored [23]:

- 14% higher in skill-based-knowledge assessments,
- 11% higher in terms of factual knowledge and
- 9% higher retention rate.

This shows that gamification not only helps learners acquire knowledge and skills more effectively, but it also allows them to retain information and commit it to long-term memory for future use.

R. N. Landers and A. K. Landers [17] identified the only psychological theory focusing upon gamified learning. This theory proposes that game elements affect training outcomes through one or two mechanisms. Firstly, gamification may be used to create a mediating behaviour or attitude which, in turn, is thought to affect learning. In an empirical test of this theory, a leaderboard was used to increase the amount of time learners spent engaging in a project, and that amount of time, in turn, increased the learning outcomes. Secondly, gamification may be used to strengthen the relationship between instructional design and learning outcomes. For example, game fiction can be used to increase learner engagement, which should make the existing course material more effective in increasing training outcomes. Critically, in both of these approaches, gamification itself is not intended to teach the learner anything; instead, it is used to support the existing instructional material [1].

The case of Walmart can serve as an example of applying gamification to train personnel on the subject of labor health and safety. The gamification-focused labor health and safety training provided two benefits in this case: competing turned out to be “addictive” and the co-workers involuntarily started talking not only about the ranking but also about the importance of compliance with labor health and safety standards. That, in turn, changed the behavior of the employees. The number of accidents declined by 54% in eight company distribution centers [25].

Any discussion on the application of gamification in the education process should be prefaced by the statement that gamification allows not only self-learning, but also knowledge sharing [29]. The aspects of cooperation, mutual education of the participants and searching for a solution by asking another employee can be included in the game. As a result, desirable characteristics of organizational culture can be developed. In this case, we can recall DuePropos which is an application for companies that fosters teamwork and competition. It helps organizations to recognize the commitments and efforts of employees in achieving the objectives together [24].

Gamification can support the process of product improvement suggestions or the participation in company-wide volunteer programs, also fostering an organizational



culture. Physical activity of employees can also be promoted in the game. Points can be awarded for participation in in-company or external sports competitions.

Gamification can be applied to everyday work performance, motivating employees to higher qualities and quantities of work output. As M. Ward rightly observes, “if people are well-motivated to work, both managing them and succeeding will be much simpler” [36]. Without attaining an adequate level of employee motivation, which is related to satisfying their needs properly, it is impossible to carry out a strategy, to implement changes in the company successfully or even to run the day-to-day business efficiently. The most effective and most frequently used method for persuading a team to carry out company goals has been to motivate it, e.g., by means of applying a reward system aimed at meeting specific needs [33]. Referring such assumptions to the above-mentioned representatives of the modern generation employees, the thesis can be put forward that the most popular forms of motivation (i.e., payroll and non-payroll ones) may not work in the long run. Herger [11] thinks that “when we talk gamification, we also talk about motivators. You may have already used bonuses, prizes, and other rewards to motivate your employees. Those rewards are what psychologists call extrinsic motivators. They come from outside an individual. They work well but have certain limits and may sometimes interfere with the intrinsic motivations. Those are motivators that come from inside an individual, such as the desire to become better in what we are doing, the desire to make friends and meet people, or to belong to a group”.

As M. Armstrong, R. Landers and A. Collmus [1] rightly point out the gamification of sales appears to be the most common form of gamification in a business setting. This is presumably because the most basic game mechanics (e.g., points, badge, and leaderboards) can be easily applied to a sales context without much thought or planning. At the same time, much like a sales function, HR teams can also use gamification internally to reward top recruiters and to incentivize employees to refer top candidates. The opportunity for an employee to earn Referrer of the Year status can encourage employees to take a more active role in talent acquisition and can even help relieve some of the pressure from the HR department itself [27]. Gamification mechanisms for conducting recruitment processes based on recommending acquaintances were implemented by Hays Poland. The objective of the activities carried out by the company was to recruit as many people as possible, aged 20–30, who were fluent in at least two foreign languages. As a result of gamification, the potential of the current staff was taken advantage of – i.e. its network of contacts – allowing the recommendation of further candidates for work. The players become NASA agents searching for candidates to populate Earth. The application is maintained in the atmosphere of tension provoked by the threat of planetary destruction. In order to reinforce the players’ involvement, the project introduced immediate feedback for the recruiters regarding the effectiveness of their actions, along with additional rewards for each subsequent stage successfully completed by the people they had recommended ([9] cited in [37]).

One may conclude that the highest level of motivation takes the form of commitment identified with passion, dedication and the willingness of an individual to invest in and contribute towards his/her employer’s success. K. Michalska [21] presents gamification as an example of a method for improving the employee potential management processes by strengthening their involvement, which has a direct impact on achieving the long-

term goals. The author argues that gamification can offer an excellent alternative to the classic approach towards basic business processes. Particular attention is paid to increasing employee performance. She describes the positive impact of gamification on company structure – improving business operations, accomplishing the effects and simultaneously and swiftly taking advantage of the opportunities presented to an enterprise. She refers to the case of the company American AC Alion, emphasizing that the application of gamification in Poland is still in the early stages of development. In the fourth quarter of 2014, the aforementioned company introduced the 12-week gamification program called “Reach the Beach” (achieving the program assumptions was rewarded by trip to the Dominican Republic) aimed at involving employees in order to meet a very ambitious goal – a 25% increase in year-on-year sales ([15] cited in [21]).

The 2018 TalentLMS Gamification at Work Survey conducted in the U.S. reported the following results [42]:

- 80% of employees enjoy using gamification software at work. They feel that gamification makes them more productive (87%), more engaged (84%) and happier (82%) at work.
- Employees were mostly motivated by intrinsic motivational factors.
- Older employees are more motivated by game elements than younger ones.

At this point it is worth focusing our attention to the last conclusion from the research. Research conducted by T. Broady, A. Chan and P. Caputi [2] has similarly shown that negative stereotypes about older people being adverse to technology and incapable of using it are outdated.

## **4 Discussion and Directions for Further Research**

Referring to the research questions put forward, it should be noted that gamification, constructed in accordance with the respective rules, results in benefits for an organization, as it is based on the player’s intrinsic motivation, raises productivity, and provides commitment and satisfaction.

There are many successful gamification examples referring to such HRM areas as recruitment and selection, onboarding, training, motivation (broadly defined) and the formation of an organizational culture. However, there are no quantitative data regarding the popularity of gamification in HRM among various types of enterprises.

In relation to the aforementioned HRM areas, the following problems – representing an interesting research challenge – can be listed:

- the impact of gamification on employer’s attractiveness perceived by the candidates for the job (including, e.g., the position hierarchy and gender),
- the comparison of the reliability of results in the course of gamified selection against the results which the candidates would have achieved in traditional tests of their skills, knowledge and personality,

- the impact of gamification on employee learning speed and the progress in learning (taking into account generational differences, position hierarchy and gender),
- the degree of participants' involvement in the game depending on the prize offered to the winners,
- the relationship between the results achieved both in the game and at work and the player type (explorer, achiever, socialiser or killer [7]).

## 5 Conclusions

The article shows that modern HRM is characterized by the use of gamification. This involves using game mechanisms in relation to real problems occurring in the workplace, for example.

It was found that gamification in HRM does not represent a highly popular topic in the high impact factor academic journals. None of the articles pertains to quantitative research in the area of gamification used in HRM. It was also found that gamification represents a relatively new problem in Polish economic practice. Inspiration can be drawn from the examples of implementing games in foreign companies.

It is worth emphasizing that gamification – just like any other solution in the area of HRM – has to be implemented with due caution. The game scenario has to be well thought-out, the technology must be adequately refined and the employees themselves cannot feel overloaded with excessive incentives. Special care should be taken while developing a system using the elements of gamification. The system has to be thoroughly tested and checked – any error, combined with all the characteristics of modern technology, may result in an unfavourable reputation spreading rapidly among the recipients.

According to research company Gartner, gamification is currently at the peak of its popularity, on the so-called life cycle curve of new technologies, along with such technologies as Big Data and 3D Printing. Due to the fact that some organizations introduce gamification using “shortcuts” – without the proper support of already proven frameworks (methodologies) – gamification, after reaching its peak, will be subject to a revision just like in the case of other technologies, consisting in the verification of its suitability and the failure of numerous incorrectly prepared projects and solutions. In 5-10 years, i.e. after verification, gamification is expected to reach its next peak, this time a more stable development [12].

**Acknowledgement.** The paper is related to the research project VEGA 1/0609/16 researching concepts of human resources management systems related to the specifics of business models of competitive organizations in European economics.

## References

1. Armstrong, M., Landers, R., Collmus, A.: Gamifying Recruitment, Selection, Training, and Performance Management: Game-Thinking in Human Resource Management. *Emerging Research and Trends in Gamification*, 140-165 (2016). DOI: 10.4018/978-1-4666-8651-9.ch007.

2. Broady, T., Chan, A., Caputi, P.: Comparison of older and younger adults' attitudes towards and abilities with computers: Implications for training and learning. *British Journal of Educational Technology*, 41(3), 473-485 (2010).
3. Burke, B.: *Gamify. How gamification motivates people to do extraordinary things*. 1st edn. Bibliomotion, Brookline, MA (2014).
4. Cherry, M. A.: The gamification of work. *Hofstra Law Review*, 40(4), 851-858 (2012).
5. Cybulski, A.: Rynek grywalizacji w Polsce i na świecie, <https://pl.linkedin.com/pulse/rynek-grywalizacji-w-polsce-i-na-%C5%9Bwiecie-arkadiusz-cybulski>, last accessed 2018/09/22.
6. Duggan, K., Shoup, K.: *Business Gamification For Dummies*. 1st edn. John Wiley & Sons, New Jersey (2013).
7. Europejski Instytut Grywalizacji Biznesu: 4 ty ty graczy, <http://www.eigb.pl/poradnik/4-typy-graczy>, last accessed 2018/09/22.
8. Fitz-enz, J.: *The ROI of Human Capital. Measuring the Economic Value of Employee Performance*. 1st edn. Amacom, New York (2000).
9. Gamfi, <http://b2b.gamfi.pl/pl/textpage/rekrutacja,54.html>, last accessed 2014/09/10.
10. Kwilosz, M.: Grywalizacja – nadchodzi nowe. *Nowe Technologie*, 1(17), 8-10 (2013).
11. Herger, M.: *Gamification in human resources*. 1 st edn. CreateSpace Independent Publishing Platform (2014).
12. Instytut Innowacyjnosci: Projektowanie Postawy Zaangażowania, <https://www.institutinnovacyjnosci.pl/oferta/projektowanie-postawy-zaangazowania-ppz/>, last accessed 2018/09/22.
13. Jankowski, M.: Grywalizacja – wykorzystanie elementów gier do modyfikowania zachowań ludzi. *Nauki Społeczne* 2(8), 139-155 (2013).
14. Joy M. M.: My Marriott Hotel - Gamification in recruitment, <https://www.slideshare.net/manumelwin/my-marriott-hotel-gamification-in-recruitment-manu-melwin-joy>, last accessed 2018/09/19.
15. Kerpen, D.: The Gamification of a Successful Sales Culture. How one CEO turned a sales competition into the trip of a lifetime, <https://www.inc.com/dave-kerpen/the-gamification-of-a-successful-sales-culture.html>, last accessed 2017/05/01.
16. Kostro, P.: Gamifikacja wkracza do polskich firm, <https://www.pb.pl/gamifikacja-wkracza-do-polskich-firm-861010>, last accessed 2018/09/25.
17. Landers, R. N., Landers, A. K.: An empirical test of the Theory of Gamified Learning: The effect of leaderboards on time-on-task and academic performance. *Simulation & Gaming*, 45(6), 769-785 (2014).
18. McGonigal, J.: *Reality is Broken*. 1st edn. The Penguin Press, New York (2011).
19. Meister, J.: Gamification: Three Ways To Use Gaming For Recruiting, Training, and Health & Wellness, [www.forbes.com/sites/jeannemeister/2012/05/21/gamification-three-ways-to-use-gaming-for-recruiting-training-and-health-amp-wellness/](http://www.forbes.com/sites/jeannemeister/2012/05/21/gamification-three-ways-to-use-gaming-for-recruiting-training-and-health-amp-wellness/), last accessed 2014/09/14.
20. Meister, J.: Future Of Work: Using Gamification For Human Resources, <https://www.forbes.com/sites/jeannemeister/2015/03/30/future-of-work-using-gamification-for-human-resources/#6fdd67c824b7>, last accessed 2018/09/22.
21. Michalska, K.: Grywalizacja jako element zarządzania strategicznego potencjałem ludzkim, *Zarządzanie. Teoria i Praktyka* 19(1), 55-62 (2017).
22. Palmer, D., Lunceford, S., Patton, A.J.: The Engagement Economy: How Gamification Is Reshaping Businesses. *Deloitte Review* 11, 52-69 (2012).
23. Pappas, Ch.: The Top Gamification Statistics And Facts For 2015 You Need To Know, <https://elearningindustry.com/top-gamification-statistics-and-facts-for-2015>, last accessed 2018/09/22.

24. Perinot, C.: Gamification in the field of human resource management. Gamified solutions for recruitment. 1st edn. Universita Ca'Foscari Venezia, Venezia (2015).
25. Piwowar-Sulej, K.: Grywalizacja jako sposób na zwiększenie zaangażowania pracowników w obszarze BHP. In: Ulewicz R., Żywiołek J. (eds.), Bezpieczeństwo systemu: człowiek – obiekt techniczny – otoczenie, Oficyna Wydawnicza Stowarzyszenia Menedżerów Jakości i Produkcji, pp. 21–31, Częstochowa (2016).
26. Piwowar-Sulej, K.: Human Resources Management in the Industrial Revolution 4.0: General and Polish Perspective. In: Jedlicka P., Marešová P., Soukal I. (eds.), Hradec Economic Days. Double-blind peer-reviewed proceedings part II of the international scientific conference Hradec Economic Days 2018, pp. 179-187, University of Hradec Kralove, Hradec Kralove (2018).
27. Sims, S.: How Gamification Can Improve HR Management, <https://www.thebalancecareers.com/gamification-hr-management-improvement-1917995>, last accessed 2018/09/22, last accessed 2018/09/24.
28. Staszal, A.: Wykorzystanie grywalizacji do zwiększenia zaangażowania pracowników. In: Piwoni-krzeszowska E., Małkus T. (eds.), Współczesne problemy zarządzania organizacjami, Mfiles, pp. 51–50, Kraków (2014).
29. Stockinger, T. et al.: Towards Leveraging Behavioral Economics in Mobile Application Design. In: Reiners T., Wood L.C. (eds.), Gamification in Education and Business, pp. 105–131, Springer, New York (2014).
30. Roberts, B.: Gamification: win, lose or draw? HR Magazine, 59(5), 29-35 (2014).
31. Ruel, H., Bondarouk, T.: Van der Vald, M.: The Contribution of e-HRM to HRM Effectiveness. Employee Relations, 29(3), 280-291 (2006), DOI: 10.1108/01425450710741757.
32. Talent Bridge: Grywalizacja w procesie rekrutacji, [www.talentbridge.pl/raporty/97-raport-grywalizacja](http://www.talentbridge.pl/raporty/97-raport-grywalizacja), last accessed 2014/09/10.
33. Tkaczyk, P.: Grywalizacja. Jak zastosować mechanizmy gier w działaniach marketingowych. 1st edn. Onepress (2012).
34. TNS Global: Raport Polska jest mobi 2015“, [http://www.tnsglobal.pl/coslychac/files/2015/05/POLSKA\\_JEST\\_MOBI\\_2015.pdf](http://www.tnsglobal.pl/coslychac/files/2015/05/POLSKA_JEST_MOBI_2015.pdf), last accessed 2016/06/07.
35. Ursprung, S.: HRM 4.0: not yet with us! Summarizing the Personal Swiss, <http://blog.jacando.com/en/hrm-4-0-noch-nicht-mit-uns-ein-besuch-an-der-personal-swiss/>, last accessed 2017/07/25.
36. Ward, M., 50 najważniejszych problemów zarządzania. 1 st edn. Wydawnictwo Profesjonalnej Szkoły Biznesu, Kraków (1997).
37. Wawer, M.: Grywalizacja - nowy trend w rekrutacji kandydatów. Studia i Prace WNEiZ, 39 (3), 219-230 (2015).
38. Wolf, M. J. P.: Before the Crash: Early Video Game History. 1st edn. Wayne State University Press, Detroit (2012).
39. Wolf, O.: Grywalizacja, czyli frajda z pracy, <http://nf.pl/manager/grywalizacja-czyli-frajda-z-pracy>, last accessed 2015/07/15.
40. Wood, L.C., Reiners, T.: Encyclopedia of information science and technology. 1st edn. Information Resource Management Association, Hershey (2005).
41. Zichermann, G., Cunningham, Ch.: Gamification by Design. Implementing Game Mechanics in Web and Mobile Apps. 1st edn. O'Reilly Media, Inc., Sebastopol (2011).
42. Zoe E.: The 2018 Gamification At Work Survey, <https://www.talentlms.com/blog/gamification-survey-results/>, last accessed 2018/09/22.

## Ecological Policy in the Selected Countries of the European Union

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**Abstract.** The free market and increasing competition in the current economy are conducive to achieving economic goals, but they may hinder the implementation of environmental goals. Such thinking has led to the emergence of new paradigms in economics, including the so-called ecological economics, which assumes that environmental goals should prevail over economic goals, although achieving them is also important. The aim of the paper is to assess the implementation of ecological policy in selected European Union countries (4 highly developed countries and 4 countries from Central and Eastern Europe). Thus, it will be possible to diagnose the relationship between the development level of the economy and the size and structure of expenses for ecological purposes. Based on the research, it was found that the share of expenditures on environmental objectives measured in relation to GDP is not directly proportional to the wealth of a given country. The situation looks different, however, when environmental protection expenditure per capita is analyzed – then the rich economies have leading positions. This can suggest that environmental protection objectives gain importance when national income increases and economic goals can be reached at a satisfactory level.

**Keywords:** Ecological Economics, Ecological Policy, European Union, Natural Environment.

### 1 Introduction

The policy connected with the protection of the natural environment is a practical implementation of the environmental economics and ecological economics assumptions. The sources of this economics can be found in the paradigm of neoclassical theory, integrating elements of economics and ecology, and combining the postulates of both these sciences resulted from public awareness of the responsibility for the natural environment and the limited resources. Environmental economics can be described as interdisciplinary science about the rational use of limited environmental resources to maximize well-being. This school investigates the static and dynamic conditions of optimal use of resources and environmental values, and its general basis is the theory of external effects and the theory of public goods. Economization of environment, the basic postulate (assumption) of the paradigm, should contribute to

more efficient use of limited capital and human resources necessary to achieve the goals that are formulated within the framework of ecological policy. Such an approach means de facto the supremacy of economic goals in relation to environmental conditions and the needs of its protection [4, 9].

Ecological economics was born in the mid-1980s on the basis of the neoclassical economics of the environment and neoclassical assumptions of the paradigm of free market and homo oeconomicus. The need to develop a new concept resulted primarily from the ahistoric nature of the previous neoclassical theory (abstraction from the uncertainty and irreversibility of processes), ignoring the limits of economic growth, too optimistic acceptance for the possibility of environment substitution by technical progress, underestimating the pollution of the natural environment and passing over the external effects of economic activity. The new approach proposed a look at the relationship between the natural environment and the economy, based on the recognition of the superiority of the natural environment to economic development [9, 16, 23, 25]. Moreover, ecological economics has become an multidisciplinary science, as it requires methodological pluralism and refers to other sciences, including biology, physics, sociology [16]. In the application dimension, ecological economics became the basis for formulating long-term economic growth strategies, in which the objectives related to the protection of the natural environment play a key role.

## **2 Research Methodology**

The aim of the publication is to assess the implementation of ecological policy in selected European Union countries. The analysis covered 8 countries, 4 of which are EU-15 (Denmark, Germany, France, Sweden), the other four are so-called new Member States (Bulgaria, the Czech Republic, Poland, Slovakia). The difference between these countries mainly concerns the level of economic development. Thus, it will be possible to diagnose the relationship between the development level of the economy and the size and structure of expenses for ecological purposes. In order to fully illustrate the relationship between the above-mentioned values, data for all EU countries were also used, calculating Pearson's correlation coefficient. The assessment will be preceded by information on the creation of waste and the emission of atmospheric pollution in the analysed countries. The selection of variables for analysis, the choice of time range (averages for 2013-2015) and spatial coverage was dictated by the availability and comparability of Eurostat data. The paper uses methods of critical analysis with elements of inductive reasoning.

## **3 Theoretical Aspects of Ecological Economics and Policy**

The main postulate of the ecological economics is to treat the earth and the world as a closed, non-growing and non-multiplying ecosystem, in which the global economy functions as one of the subsystems [8]. On the one hand, the economy uses natural resources, and on the other hand, it utilizes waste in the environment, so that the natural environment determines the barrier of economic growth and the limits of resource use

[27]. Ecological economics proposes, therefore, striving to create a sustainable social system in which the high quality of life and the occurrence of limitations related to the natural environment are in harmony [20]. Improvement of production processes (through the implementation of scientific and technical progress, increase in the efficiency of resource use) may shift this boundary, however in the long term it is necessary to preserve the environment in such a form that it is able to restitution. Due to the fact that certain economic activities may have irreversible effects on the natural environment, it is necessary to observe the principle of prevention and the activity of economic policy (instead of conducting a passive policy reacting afterwards) [8, 27]. The long-term and holistic approach to the above relations creates real opportunities for achieving an intergenerational balance [20].

In ecological economics there is considered the paradigm of “greening” economics joint with economic activity, which can be defined as the ecological paradigm of economics. The basis for this thinking is “ecocentrism”, as opposed to environmental economics and its egocentrism. These different approaches result directly from the relationship between human managing resources and the natural environment. Ecological economics treats ecological conditions and goals of economic development as superior to postulates formulated and analyzed within the framework of neoclassical economics [4, 9]. Within the framework of ecological economics, the trend in Germany was known as the new environmental economy, significantly different from the neoclassical environmental economics. Its originators note that it is an attempt to develop an ecological economy towards a sustainable development economy, thus many postulates are very similar or even identical. In fact, ecological economics was a ground for the economy of sustainable development. It can be therefore concluded that, as in the case of the concept of sustainable development, the economic dimension in ecological economics is no longer the most important, and economic development is not a parent goal. Blind faith in the free market and the mechanism of competition can be an obstacle to the achievement of environmental goals and its protection. For this reason, it seems that a certain scope of the state's intervention policy is necessary, thanks to which the values of the natural environment could be preserved in the right form in the long term. It would be beneficial from the point of view of people health and quality of life, and thus the economy and the state budget. Social welfare in the long term depends not only on economic factors, but increasingly on environmental ones, that is why the approach treating these two elements in at least equivalent way is an important message for the formulation of economic policy, including ecological policy.

Ecological policy in the general sense is conscious and purposeful activity of the state, local governments and economic entities in the field of environmental management, including the use of its resources and assets, protection and shaping of ecosystems or selected elements of the biosphere [21]. Main aim of the policy is to ensure effective actions and implementation of law strengthening the protection and safe use of the environment. Ecological policy occupies a unique place in the entire policy of the state. Besides economic and social policy, it is the most important element of state management and includes, inter alia, protection of nature and the Earth's surface, water management, spatial management and protection of climate and



atmosphere [22]. Its multi-faceted management of environmental processes is designed to make them efficient and effective. It sets only general directions of action, and its detailed implementation is based on specific program documents, such as executive programs for policy or sectoral documents [5]. The way of conducting ecological policy depends on general state models, the political and economic system, as well as values and traditions prevailing in society. In this connection, it can be said that the government activity affects the interests of all citizens groups. They determine the model of ecological policy used in certain conditions. In this context, two are mentioned:

- liberal – focused on individual entrepreneurship and responsibility in the aspect of environmental protection, which is included in the system of market prices,
- social-democratic – integration of economic, social and ecological policies, in which the responsibility for environmental protection lies on the side of state, through various types of norms and legal framework and budgetary expenditure.

Ecological policy should be implemented in an effective and fair method and primarily socially acceptable. This fairness could be manifested by the imposition of financial commitment on entities that participate in the production of pollution or have economic benefits from environmental goods. The principles of such an approach have been developed many times by international organizations and groups, including EU or OECD. Separate regulations are developed within the framework of national state environmental policies. There are obviously many discussions and controversies about state policy and its scope in the national economy in general. It is worth to point out that solutions under the ecological policy can be consistent with the functioning of the market mechanism. Bell [2] suggest that state can promote ecological actions and it can have with the liberalism much in common. The concept of connecting these issues is ecological liberalism.

### **3.1 Instruments of Ecological Policy**

One of the main factors that contributed to the current state of degradation and depletion of the natural environment is the fact that environmental aspects are not taken into account in the production processes. This applies to both enterprises, primarily those associated with high consumption of resources, and the agriculture sector, which uses a large part of land on Earth. This has an impact on the deterioration of the quality of natural resources, which in turn causes problems with the economic growth [7].

The state is obliged to take appropriate actions to protect the remaining natural resources and prevent their further degradation. However, this interference should not interfere with the functioning of the market mechanism. Under the environmental policy the state has a wide range of instruments, from which specific tools adequate to specific situations can be chosen [17]. Their choice is determined by the issue of internalization of external costs (i.e. negative externalities) occurring in the environment and resulting from human economic activity. These costs are understood as damage to health or damage to the environment and could be valued in money. According to the theory of internalisation of external costs, the perpetrator should incur

these costs (e.g. through the ecological tax) – in this context they become part of the economic account of the given entity [2, 24]. Depending on the nature of their activities, these instruments can broadly be divided into [17]: (1) direct regulations (also referred to as administrative and legal instruments) and (2) indirect regulations (economic or market instruments). The above types of instruments often are interrelated. This is because in a democratic system the use of economic instruments involves the adoption of legal acts, and in turn failure to comply with legal obligations may involve fines [17]. The division of instruments can also be more detailed. Accordingly, direct instruments can be divided into legal and administrative instruments as well as administrative procedures. While indirect instruments are divided into economic and tools of social impacts or of voluntary use.

Direct instruments are used to assume that without their presence, entities would not take appropriate actions or undertake activities incompatible with the adopted environmental policy of public authorities. They are therefore distinguished by the prohibitive or prescriptive character of the provisions. The use of these instruments creates a direct compulsion to enforce environmental protection regulations, and in the case of infringements, sanctions are a consequence. Typical direct instruments include [17]:

- standards for the use of the environment (e.g. possible maximum volume of emissions per production unit);
- determining the amount of mandatory reduction of pollution;
- individual permits for entities specifying limits and conditions for using the environment;
- technological standards (e.g. BAT or BACT);
- obligatory procedures (e.g. environmental impact assessment);
- obligations and prohibitions;
- operating and utilization licenses for individual entities.

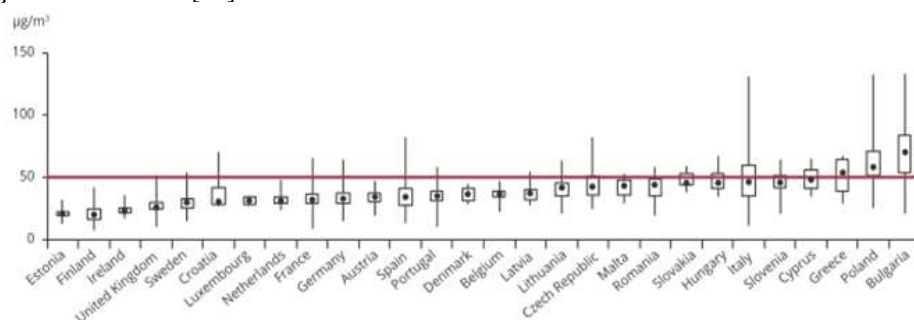
In turn, indirect instruments are used because they significantly reduce the social costs of achieving the desired environmental status compared to direct instruments. These instruments, by means of indirect coercion, affect the entities using the resources of the environment and force them to take appropriate actions. These instruments include [17]:

- penalties for the emission of pollutions (in the case of exceeding the limits set in the legislation);
- fees for quantitative environmental degradation (e.g. use of agricultural land for purposes other than agricultural);
- system of tax differentiation (coal tax, ecological fuel tax);
- credits for emission reduction, tradable emission rights, etc;
- transferable certificates that confirm the achievement of environmental goals (green, red, white, brown certificates);
- ecological deposits, which are collateral for the obligations of entities to reduce the environmental nuisance of their operations;
- fees for the economic use of the environment.

Ecological policy usually uses a set of instruments, appropriately selecting direct and indirect instruments. Direct instruments are strengthened or supplemented in particular by economic instruments, e.g. various types of subsidies and investment support for environmental actions. In addition to the standard division of environmental policy instruments, we can also distinguish persuasive instruments, among others those that rely on the transmission of information. They assume that the behavior of entities depends on the acquisition and production of information. A separate group is also environmental management instruments, such as ecological reviews, non-normative and normative environmental management systems. Sometimes, planning and information instruments are also distinguished, which include, in particular, various spatial planning procedures.

#### 4 Emission of Pollutants and Implementation of Ecological Policy in the Selected Countries

It is widely believed that in the less affluent European Union countries the level of environmental pollution is higher than in the rich countries of Western Europe. This is testified by reports on the concentration of dangerous substances in the air for the countries covered by the observation (see Fig. 1). Permissible PM10 and PM2.5 standards are more often exceeded in the eastern part of the EU (e.g. Poland, Bulgaria) than in its central and southern part (the northern part of Italy is an exception) and by far the lowest in the northern part of the region (Sweden, Finland, Estonia) [13]. A similar situation applies to toxic benzopyrene (benzo[a]pyrene – BaP), which is one of the PM suspended particulate components. The main cause of the emission is the burning of coal in old and often poorly adjusted domestic furnaces, practiced by the inhabitants of less developed EU regions [see 18]. Losses on this account can be expressed not only in the economic sense (costs of medical treatment, decrease in labor productivity due to absenteeism at work), but above all in the social dimension – premature deaths [12].



**Fig. 1.** PM10 concentrations in relation to the daily limit value (50 µg/m³) in 2015 in the EU countries [14].

The above data are, however, based on measurement systems located in an urbanized area. Therefore, they do not reflect the situation for the country in general, but only for

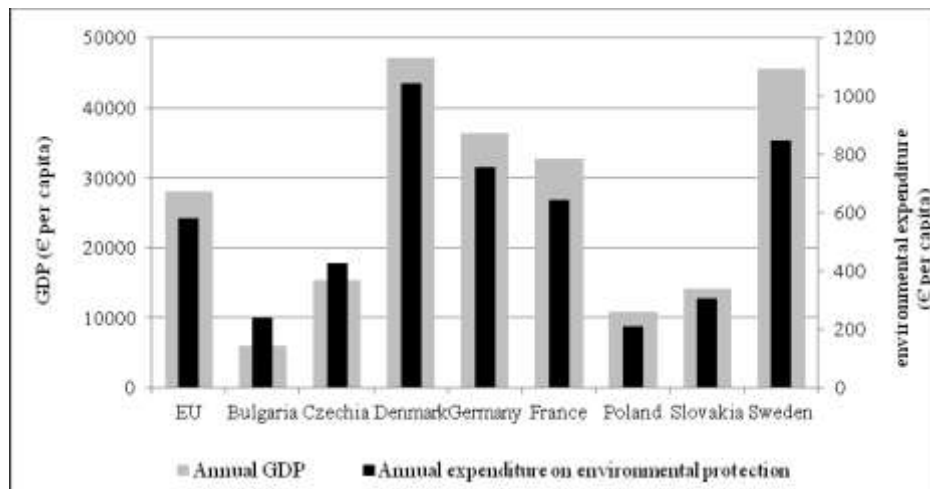
its regions, which may lead to wrong conclusions. If we look at the numbers in table 1, we can see that the total level of particulate emissions per km<sup>2</sup> in Denmark and Germany (in Denmark also in terms of per capita) is higher than in Bulgaria and the Czech Republic. Secondly, higher industrialization, including agriculture, and a more developed transport sector in terms of quantity contribute to increased greenhouse gas emissions in the above two highly developed economies [11]. Highly developed countries also produce a relatively large amount of waste. Even perceived as environmentally friendly, Sweden produces more waste per unit area than the Czech Republic and Slovakia (and per capita this ratio exceeds all analyzed countries, except Bulgaria). Therefore, if we take into account the total impact of human activities on the natural environment, we can say that the largest “polluters” are highly developed economies. On the global scale, the largest emitters of greenhouse gases (per capita) include the United States, Australia and Canada, while Germany and France rank among the top 10 countries [26]. In turn, the quality of the natural environment in less wealthy countries is in many cases better, as evidenced, inter alia, by Jaworska's [19] research. It shows that countries such as Bulgaria and Poland in the ranking of the quality of the natural environment are at the forefront of the EU countries (in 2013 Bulgaria was the 5th, Poland – the 6th). For this assessment, the mentioned author used a synthetic indicator that includes the emission of various types of chemical substances, the amount of waste generated, stored and smoked, the share of expenditures on environmental protection and the share of renewable energy [19].

**Table 1.** PM10 Generation of waste and air emissions in selected EU countries (2013-2015 average) [15].

Country	Waste production		Greenhouse gases		Particulates < 2.5µm		Particulates < 10µm	
	t./km <sup>2</sup>	t./per.	t./km <sup>2</sup>	t./per.	t./km <sup>2</sup>	kg/per.	t./km <sup>2</sup>	kg/per.
Bulgaria	1 385.8	21,3	513.6	7,9	260.7	4,0	434.6	6,7
Czechia	304.1	2,3	1 437.1	10,8	300.2	2,2	457.0	3,4
Denmark	451.8	3,5	1 979.7	15,1	855.1	6,5	1 102.3	8,4
Germany	1 075.0	4,7	2 697.0	14,6	513.2	2,3	878.3	3,9
France	602.6	5,0	830.1	5,6	324.5	2,7	512.0	4,2
Poland	556.1	4,6	1 236.0	10,2	414.3	3,4	734.6	6,1
Slovakia	189.7	1,7	834.4	7,5	603.2	5,5	748.0	6,8
Sweden	344.5	16,0	136.6	6,3	59.4	2,8	102.1	4,7

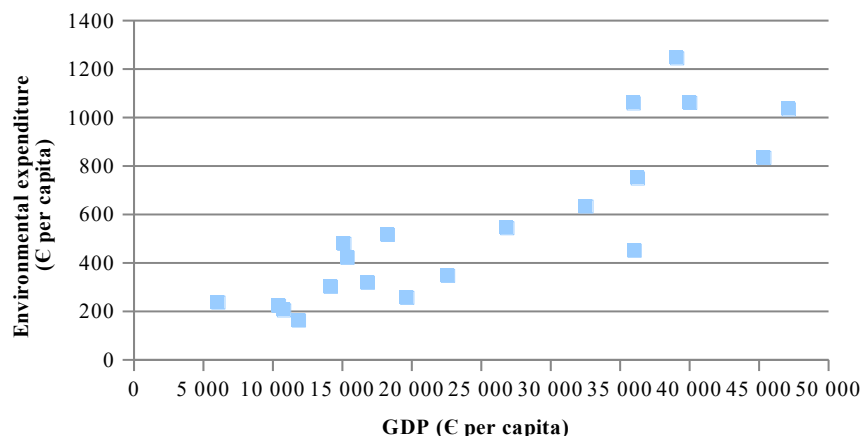
The above mentioned data could indicate that if affluent countries have the most negative impact on the natural environment, they should participate to a sufficiently high extent in expenditure related to nature. However, based on the analysis of the data, it was stated that the share of expenditures on environmental objectives measured in relation to GDP is not directly proportional to the wealth of a given country. It turns out that the largest amount of money in relative terms in 2013-2015 for environmental protection has been allocated by Bulgaria – about 4% of GDP. The Czech Republic

ranked second – 2.8% and Denmark – 2.2%. The lowest rate was recorded by Poland and Sweden – 1.9%. The high position of Bulgaria in this ranking has been maintained for many years. The report of the European Commission prepared in 2011 confirms this data, at the same time indicating a very low (as in Romania) efficiency of using energy and resources in the process of manufacturing goods and services [10]. In this case ecological investments can therefore be regarded as necessary to move to the higher path of “environmental productivity”.



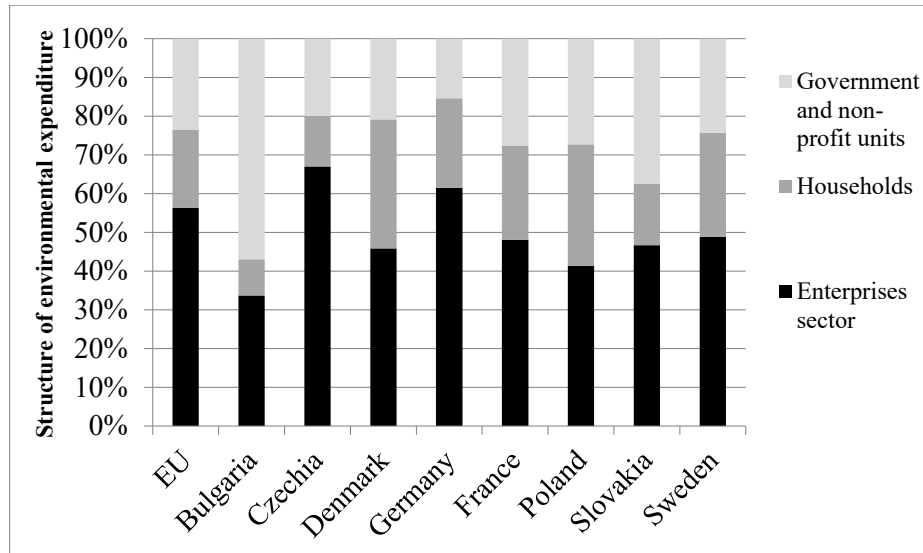
**Fig. 2.** Annual GDP (left axis) and annual expenditure on environmental protection (right axis) in selected EU countries (2013-2015 average) [15].

A clear, positive relation occurs in relation to the size of GDP per capita and environmental expenditure per capita (see Fig. 2). This way of presenting a relationship seems even more adequate. The low share of environmental expenditure in GDP does not have to mean a low per capita ratio, especially for countries with high total GDP. It can also be assumed that if a high level of national income leads to a relatively high level of environmental pollution, and this in turn to negative effects on humans, then human should be a criterion for determining expenditures on pro-ecological activities. As a result, among the economies studied, the highest level of environmental expenditure (per capita) refers to Denmark, Sweden, Germany and France, the lowest to Poland and Bulgaria. Such a payment allocation system can be considered fair in the context of the impact of individual countries on the environment, including climate change occurring in recent years. In turn, a similar analysis carried out for 20 EU countries for which complete data was available showed that the Pearson's correlation coefficient for GDP and environmental expenditure per capita amounted to as much as 0.86 for the years 2013-2015, which means a strong positive relationship between these values [15]. Figure 3 presents a scatter plot for the data described.



**Fig. 3.** Relationship between GDP per capita and expenditure on environmental protection per capita in EU countries (on average for the years 2013-2015) [15].

Analyzing the expenditure for environmental protection, it is worth noting their structure by the sector that makes this expenditure – then we can distinguish the private sector (households and enterprises) as well as the government and non-profit organizations. The largest amount of budget funds (plus non-profit institutions) in relative terms (as a % of all sectors' expenditure) is allocated in Bulgaria (57%), followed by Slovakia (37%). The lowest relative public expenditure are recorded in Germany (15%), followed by the Czech Republic and Denmark (20% and 21%). Regarding private sector expenditure, corporate spending is dominant – up to 67% in the Czech Republic and 61% in Germany. On the other hand, households bear the relatively high burden of environmental financing in Denmark (33%) and Poland (31%), and the smallest – in Bulgaria (only 9%) (fig. 4). The data would suggest that the above-mentioned social democratic model, in which the responsibility for environmental protection is primarily borne by the state, is common to Bulgaria and Slovakia, while Germany, the Czech Republic, Denmark and Sweden are farthest away from it, which would mean the dominance of the liberal model there. Such a situation in Bulgaria may result from the fact that it is still a country with relatively low national income (both total and per capita) and only the state (in conjunction with non-profit organizations) is willing to allocate funds for environmental purposes, while the private sector is primarily interested in economic goals. On the other hand, countries with high private sector spending on environmental protection belong to rich societies, more aware of the need to protect the environment and more willing to bear financial burdens in this area.



**Fig. 4.** Structure of national expenditure on environmental protection by institutional sector in selected EU countries (2013-2015 average) [15].

Finally, it is worth noting that the system of institutional expenditures on environmental protection in the case of some countries does not coincide with the market economy model existing in these countries. For example, in the Scandinavian countries, there is a welfare system in which government spending has a relatively high share in GDP creation. Meanwhile, the share of budget expenditures and non-profit organizations for environmental protection compared to private sector expenditure is relatively small. A similar situation occurs in Germany. On the other hand, in the Czech Republic, characterized by a relatively high degree of liberalization (total index of economic freedom in 2018 amounted to 74.2 points out of 100, which is 24th in the world; [1], private sector expenditure on environmental objectives they are relatively high [6]. In this case, we can therefore speak about the coherence of the ecological policy model with the market economy model.

## 5 Conclusions

The free market and increasing competition in the economy are conducive to achieving economic goals, but they may hinder the implementation of environmental goals. Such thinking has led to the emergence of new paradigms in economics, including the so-called ecological economics, which assumes that environmental goals should prevail over economic goals, although achieving them is also important. The implementation of the assumptions of this economic theory is expressed in the so-called ecological policy. The aim of the article was to assess application of ecological policy in selected European Union countries with a diversified level of development. Based on the research, it was found that the share of expenditures on environmental objectives

measured in relation to GDP is not directly proportional to the wealth of a given country. The leader in this area is the poorest of the analyzed countries - Bulgaria, which allocates 4% of GDP for environmental purposes, and many times richer Sweden, France and Germany - only about 2%. The situation looks different, however, when environmental protection expenditure per capita is analyzed - then the rich economies have leading positions, in particular Denmark, where one inhabitant spends 4 times more on average for these purposes than the citizen in Bulgaria and 5 times more than in Poland. In the middle of the ranking there is the Czech Republic. This suggests directly that environmental protection objectives gain importance when national income increases and economic goals (including those related to consumer demand) can be reached at a satisfactory level. There are also differences in expenses for environmental purposes, taking into account the institutions implementing them. In the poorer countries, the largest part of expenditure on environmental protection is borne by the government sector, and in the richer countries - the private sector, mainly enterprises. Relatively high private sector expenditure under the environmental policy may indicate that the public is more aware of the need to protect the natural environment and willing to participate in the costs of its financing.

## 6 References

1. 2018 Index of Economic freedom. <https://www.heritage.org/index/ranking>, URL, last accessed 2018/10/26.
2. Adaman, F., Madra, Y. M.: Understanding Neoliberalism as Economization: The Case of the Environment. In: Atasoy, Y. (ed.) *Global Economic Crisis and the Politics of Diversity*, pp. 29-51. Palgrave Macmillan, London (2014).
3. Bell, R. D.: Political Liberalism and Ecological Justice. *Analyse & Kritik*, vol. 28, 206-222 (2006).
4. Borys, T.: Nowe kierunki ekonomii środowiska i zasobów naturalnych w aspekcie nowej perspektywy finansowej Unii Europejskiej. *Ekonomia i Środowisko*, vol. 1 (44), 8-28 (2013).
5. Burzyńska D.: Rola inwestycji ekologicznych w zrównoważonym rozwoju gmin w Polsce. Uniwersytet Łódzki Publisher, Łódź (2012).
6. Central Intelligence Agency. The World Factbook: GDP – composition, by end use, <https://www.cia.gov/library/publications/the-world-factbook/fields/2259.html>, URL, last accessed 2018/10/28.
7. Centrum Doradztwa Rolniczego – Oddział w Poznaniu: Ochrona środowiska w gospodarstwie rolnym. Poradnik dla doradcy, [https://www.cdr.gov.pl/pol/wydawnictwa/ochrona\\_srod.pdf](https://www.cdr.gov.pl/pol/wydawnictwa/ochrona_srod.pdf), last accessed 2018/10/2018.
8. Constanza, R., Cumberland, J., Daly, H., Goodland, R., Norgaard, R.: *An introduction to ecological economics*, St. Lucie Press and ISER, Boca Raton, USA (1997).
9. Czaja, S.: Problemy badawcze oraz wyzwania rozwojowe ekonomii środowiska i zasobów naturalnych. *Ekonomia i Środowisko*, vol. 3 (43), 28-50 (2012).
10. European Commission: EU environment policy supporting jobs and growth, [http://ec.europa.eu/environment/enveco/industry\\_employment/pdf/facts\\_and\\_figures.pdf](http://ec.europa.eu/environment/enveco/industry_employment/pdf/facts_and_figures.pdf), last accessed 2018/10/27.
11. European Environment Agency: Adams, M.: Air quality in Europe. Status and opportunities, [https://mfvm.dk/fileadmin/user\\_upload/MFVM/Miljoe/Luftvision/EEA\\_Air\\_pollution\\_Ren\\_luft-vision\\_1June2017.pdf](https://mfvm.dk/fileadmin/user_upload/MFVM/Miljoe/Luftvision/EEA_Air_pollution_Ren_luft-vision_1June2017.pdf), last accessed 2018/10/28.



12. European Environment Agency: Air quality in Europe – 2017 report, [https://www.eea.europa.eu/publications/air-quality-in-europe-2017/at\\_download/file](https://www.eea.europa.eu/publications/air-quality-in-europe-2017/at_download/file), last accessed 2018/10/27.
13. European Environment Agency. Air quality index, <https://www.eea.europa.eu/themes/air/air-quality-index>, URL, last accessed 2018/10/10.
14. European Environment Agency. Air Quality e-Reporting Database, <http://www.eea.europa.eu/data-and-maps/data/aqereporting-2>, URL, last accessed 2018/10/10.
15. Eurostat database. <http://ec.europa.eu/eurostat/data/database>, URL, last accessed 2018/10/27.
16. Famielec, J.: Ekologizacja jako paradygmat rozwoju społeczno-gospodarczego. In: Kożuch, M. (ed.) Ekologizacja gospodarki, pp. 11-30. Uniwersytet Ekonomiczny w Krakowie (2015).
17. Graczyk, A.: Instrumenty rynkowe polityki ekologicznej. Teoria i praktyka, Wrocław (2013).
18. Instytut Ochrony Środowiska – PIB: Krajowy bilans emisji SO<sub>2</sub>, NO<sub>2</sub>, CO<sub>2</sub>, NH<sub>3</sub>, NMLZO, pyłów, metali ciężkich i TZO za lata 2013-2014 w układzie klasyfikacji SNAP i NFR. Raport podstawowy. Warszawa (2016).
19. Jaworska, M.: Analiza dystansu Polski do krajów Unii Europejskiej pod względem ochrony środowiska naturalnego. Metody ilościowe w badaniach ekonomicznych, vol. XVII/2, 46-53 (2016).
20. Matuszczak, A.: Zróżnicowanie rozwoju rolnictwa w regionach Unii Europejskiej w aspekcie jego zrównoważenia. PWN, Warszawa (2013).
21. Poskrobko, T.: Polityka ekologiczna. Instrumenty planistyczne, [http://www.studentom.tposkrobko.pl/files/pos\\_polityka\\_ekologiczna.pdf](http://www.studentom.tposkrobko.pl/files/pos_polityka_ekologiczna.pdf), last accessed 2017/09/05.
22. Poskrobko, B., Poskrobko, T.: Zarządzanie środowiskiem w Polsce. PWE, Warszawa (2012).
23. Prandecki, K. (ed.): Z badań nad rolnictwem społecznie zrównoważonym (25). Produktywność wybranych form rolnictwa zrównoważonego. IERiGŻ-PIB, Warszawa (2014).
24. Prandecki, K., Buks, J.: Dobra publiczne i efekty zewnętrzne – ujęcie teoretyczne. In: Prandecki, K. (ed.) Z badań nad rolnictwem społecznie zrównoważonym (32). Efekty zewnętrzne i dobra wspólne w rolnictwie – identyfikacja problemu, pp. 22-45. IERiGŻ-PIB, Warszawa (2015).
25. Rogall, H.: Nachhaltige Ökonomie: Ökonomische Theorie und Praxis einer Nachhaltigen Entwicklung. Metropolis, Marburg (2009).
26. The World Bank. <https://data.worldbank.org/indicator>, URL, last accessed 2018/10/13.
27. Zegar, J. S.: Koncepcja badań nad rolnictwem społecznie zrównoważonym. In: Zegar, J. S. (ed.) Koncepcja badań nad rolnictwem społecznie zrównoważonym, pp. 7-21. IERiGŻ-PIB, Warszawa (2005).

## Impact of Selected Determinants of Innovation on the Economic Growth of the Visegrad Group Countries

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**Abstract.** The proposed article deals with the innovativeness of the Visegrad Group countries in the context of economic growth. Because of the clarity of the considerations, the work was divided into several basic parts. In the theoretical part, economic growth was discussed in a synthetic way, while further considerations were devoted to econometric modeling. The whole was crowned with a summary and conclusions. There were two research methods used in the study: statistical data analysis and econometric analysis. The general purpose of the considerations was to identify statistically significant determinants of innovation affecting the economic growth of the V4 countries. The estimation was carried out using the classic method of least squares. As the explained variable, GDP was chosen, while the statistically significant variable, with the 0.01 significance level, turned out to be the variable unemployed with higher education at 10,000. residents. In contrast, statistically significant variables at the 0.05 significance level turned out to be internal R & D expenditure of the enterprise sector at 10,000. residents and internal government spending on R & D at 10,000 residents. The examined econometric model also includes state budget funds for industrial production and technologies, employed in science and technology as well as zero-one variables. Statistical data used in the study were taken from the European Statistical Office, the research period was set for 2005-2016.

**Keywords:** Econometric Analysis, Innovation, Visegrad Group.

### 1 Introduction

In the modern world, various types of phenomena, e.g. economic ones [more broadly: 1; 16; 20], social or natural are almost always conditioned by the action of other phenomena. Therefore, the existence of relationships between phenomena is often the subject of scientific inquiries. Thus, in the presented article, it was decided to examine one of many ever-striking phenomena, namely the problem of economic growth [see 6; 12].

The paper analyzes the impact of selected factors on economic growth in countries belonging to the Visegrad Group, i.e. in Poland, Slovakia, the Czech Republic and Hungary [cf. 14]. Therefore, the study covered four countries with diversified economic level, while the research period was limited to twelve years, i.e. from 2005 to 2016. The

study did not include the last year, i.e. 2017 due to the lack of data at the time of preparing the proposed analysis. It is worth noting that work on the model used GNU Regression Econometric and Time-Series Library - gretl, which provides advanced econometric methods.

The main research goal was to identify statistically significant determinants of innovation affecting the economic growth of four countries belonging to the Visegrad Group. However, it was decided to extend the analysis to include specific objectives, which are an attempt to find answers to the following research questions:

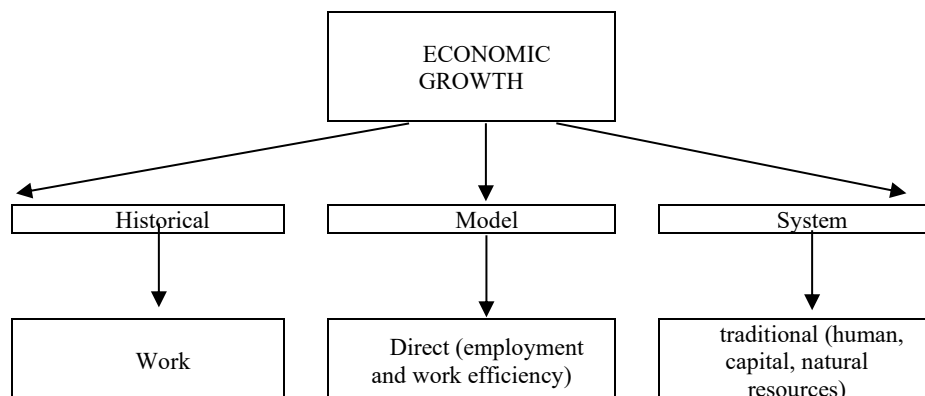
- Is the panel analysis helpful in solving problems related to the presentation of factors determining economic growth in the Visegrad Group countries?
- Did all of the examined explanatory variables interact in a statistically significant way with the explained variable?
- Which of the studied variables had a strong influence on the shaping of the explained variable?
- Which of the zero-one variables turned out to be statistically significant for the estimated model?

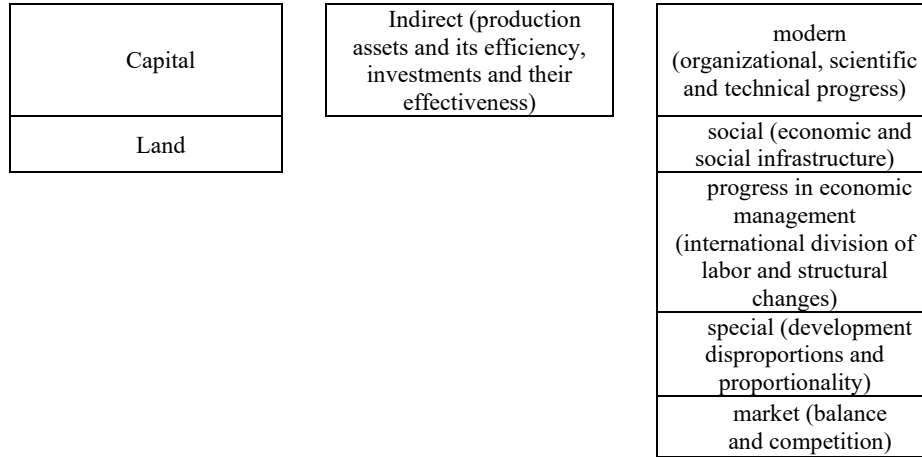
Based on the results obtained from the conducted analysis, which consisted in building and estimating the econometric model, all the research goals were achieved.

## 2 Economic Growth in a Synthetic Theoretical Approach

Economic growth can be seen as increasing the capacity of a given society to produce goods and services within the entire economy. Therefore, in the theory of economics, the term economic growth is used to describe quantitative changes. However, it should be noted that in the case of defining economic development, in addition to the aforementioned aspect, qualitative changes and changes in the structure of the economy are also taken into account [5]. The most frequently used quantitative reflection of economic growth is the increase in the real value of GDP in the economy.

In the subject literature one can find three basic accounts of factors affecting economic growth. This aspect is presented in Figure 1.





**Fig. 1.** Three approaches to economic growth factors [13, 17].

The fundamental aspects determining economic growth are labor productivity and employment growth. These elements constitute the national income. Growth also generates a combination of such factors as the process of creating a convergent to a country-specific path of sustainable growth, showing the development of *per capita* production; technological development; changes in expenditures on human capital, changes in investments and paths of sustainable growth [10].

Observing a specific industry, it is noticeable that the average increase in productivity can be presented as the merging of the following elements [10]:

- increase in participation in the market of enterprises with high productivity;
- increase in productivity inside enterprises already operating;
- building new business entities that replace entities with lower productivity.

### 3 Econometric Analysis

#### 3.1 Constructing the Model

The econometric analysis was carried out on panel data, i.e. those that are observed in at least two dimensions [11]. In other words, this type of data is a two-dimensional variable, conditioned in time and space.

The study decided to examine selected determinants of innovation [more 7; 21] in the context of economic growth of the Visegrad Group countries in 2005-2016. Value gains and zero-one variables were used. Assuming that the index  $i = 1, 2, \dots, N$  marks the following areas (states V4), and the index  $t = 1, 2, \dots, T$  marks time units (see Table 1), then the constructed model will be in the form:

$$Y_{it} = \alpha_1 X_{1it} + \alpha_2 X_{2it} + \alpha_3 X_{3it} + \alpha_4 X_{4it} + \alpha_5 X_{5it} + Cz + H + P + v_{it}, \quad (1)$$

where:

**explained variable:**

$Y_{it}$  – Gross Domestic Product at current market prices at 10,000 residents,

**explanatory variables:**

$X_{1it}$  – Internal expenditure on R & D of the enterprise sector at 10,000 residents,

$X_{2it}$  – Internal government spending on R & D at 10,000 residents,

$X_{3it}$  – State budget funds for industrial production and technologies for 10,000 residents,

$X_{4it}$  – Unemployed people with higher education at 10,000 residents,

$X_{5it}$  – Employed in science and technology for 10,000 residents,

Cz – zero-one variable for the Czech Republic,

H – zero-one variable for Hungary,

P – zero-one variable for Poland,

$v_{it}$  – total random error (consisting of a purely random part  $\varepsilon_{it}$  and individual effect  $u_i$ , therefore  $v_{it} = \varepsilon_{it} + u_i$ ) [15].

**Table 1.** Assignment of indices to individual countries of the Visegrad Group and respective periods.

	i	t
1	Czech Republic	2005
2	Hungary	2006
3	Poland [vide 18]	2007
4	Slovakia [vide 2; 18]	2008
		2009
		2010
		2011
		2012
		2013
		2014
		2015
		2016

When starting work related to econometric modeling, a set of statistical data should be first developed. Each data set is classified into one of three types: cross-sectional data, time series and panel data. In the estimated case, the latter ones were used, in other words, space-time, i.e. observed in many areas for many periods of time [9]. It is worth emphasizing that the data type declaration is an important element during process modeling, because a particular type of data determines the right methods and tools for the selected data type [15]. The empirical studies used statistical data taken from the Eurostat database [8].

In the next step, we should focus on the organization of panel data. The indices of units and (for individual V4 countries) and time t (2005-2016) were used.

The results of the model described above are presented in the following tables. The results of the most important and, at the same time, necessary tests are put below them.

### 3.2 Results of the Model Estimation

Estimation using the classical least squares method (CLSM) is considered acceptable when the individual effect does not occur and the panel is treated as a cross-sectional data set. This kind of situation happens in the examined model [vide 19].

Using the GRETL econometric program, the estimation presented in table 2 was obtained. It contains the values characterizing and describing the results of least squares estimation. The test for distribution normality is presented in Figure 2.

**Table 2.** Model 1: Panel estimation LSM, using 48 observations, 4 units of cross-section data were included, Time series length = 12, Dependent variable (Y): Yit [own elaboration based on the GRETL program].

	Factor	Std. error	Student's t-	P value	
const	6,03717	2,03689	2,964	0,0052	***
X1it	39,9913	17,1090	2,337	0,0246	**
X2it	39,5526	17,3784	2,276	0,0284	**
X3it	8,01838	10,7498	0,7459	0,4602	
X4it	-401,124	144,454	-2,777	0,0084	***
X5it	172,846	108,150	1,598	0,1181	
Cz	-4,20596	2,84193	-1,480	0,1469	
H	-5,21639	2,72466	-1,915	0,0629	*
P	-3,25356	2,73545	-1,189	0,2415	
<hr/>					
The arithmetic mean of the dependent variable		5,189866	Standard deviation of a dependent variable	7,430614	
The sum of residual squares		1666,281	Standard error of residues	6,536449	
R-squared determination coefficient		0,357902	Adjusted R-square	0,226190	
F(8, 39)		2,717303	The p-value for the F test	0,017578	
Logarithm of credibility		-153,2406	Akaike information criterion	324,4812	
Schwarz Bayesian criterion		341,3220	Hannan-Quinn criterion	330,8454	
Autocorrelation of residues - rho1		-0,078460	Durbin-Watson statistics	2,004700	

The first step in assessing the quality of the econometric model is to assess the significance of the impact of individual independent variables on the dependent variable. For this purpose, the Student's t-test of significance of the  $\alpha$  parameter was used. If a given variable is marked with three asterisks (\*\*\*), the variable is significant at the 1% significance level, if two (\*\*), at 5%, and if one (\*) is at 10% [15].

In table 2 in the penultimate column there is an empirical significance level p (test probability), which additionally allows to indicate the weakest model variable. However, the F-Snedecor test (Statistics F) enables a comprehensive assessment of the suitability of the econometric model.

After the panel estimation, the main model took the following form [vide 3;4]:

$$Y = \underset{(2,03)}{6} + \underset{(17,10)}{39} X_1 + \underset{(17,37)}{39} X_2 + \underset{(10,74)}{8} X_3 - \underset{(144,45)}{401} X_4 + \underset{(108,15)}{172} X_5 - \underset{(2,84)}{4} Cz \\ - \underset{(2,72)}{5} H - \underset{(2,73)}{3} P \quad (2)$$

The equations describing particular countries of the Visegrad Group are as follows:

- Poland:

$$Y_P = 2,79 + 39X_1 + 39X_2 + 8X_3 - 401X_4 + 172X_5 \quad (3)$$

- Hungary:

$$Y_H = 0,82 + 39X_1 + 39X_2 + 8X_3 - 401X_4 + 172X_5 \quad (4)$$

- Czech Republic:

$$Y_{Cz} = 1,83 + 39X_1 + 39X_2 + 8X_3 - 401X_4 + 172X_5 \quad (5)$$

- Slovakia:

$$Y_S = 6,04 + 39X_1 + 39X_2 + 8X_3 - 401X_4 + 172X_5 \quad (6)$$

On the basis of the conducted research, it can be concluded that three of the analyzed variables, i.e.: unemployed with higher education at 10,000. inhabitants, internal expenditure on R & D of the enterprise sector for 10,000 residents and internal government spending on R & D at 10,000 people are good stimulators for the Gross Domestic Product in the Visegrad Group countries. This is confirmed by the level of their significance:  $X_{4it}$  - 0,01;  $X_{1it}$  and  $X_{2it}$  - 0,05.

Excluding the constant, the largest p value is for variable 6 ( $X_{3it}$ ).

The evaluation of the normality of the distribution of residuals was carried out using the Doornik-Hansen test verifying the hypothesis on the normality of the residual distribution.

#### **Test for normality of residual distribution:**

Null hypothesis: the random component has a normal distribution.

Test statistics: Chi-square (2) = 0.701282, with a p value of 0.704237.

#### **The Chow test for structural changes in the distribution of the sample in the observation 2:12**

Null hypothesis: no structural changes.

Test statistics:  $F(6, 33) = 0,871212$ ,

with p value =  $P(F(6, 33) > 0,871212) = 0,52633$ .

Evaluation of homogeneity of the variance of the random component - heteroskedasticity of the random component was done with the White test. This test assumes verification of the significance of regression determined for residual squares with a set of model variables, their squares and products.

#### **White's test on heteroscedasticity of residues (variability of residual variance):**

Null hypothesis: heteroscedasticity of residues does not occur.

Test statistics: LM = 41,1026,

with p value =  $P(\text{Chi-square}(38) > 41,1026) = 0,336254$ .

#### **Cumulative distribution of Waltz's heterokedasticity test:**

Null hypothesis: units have a common residual variance.

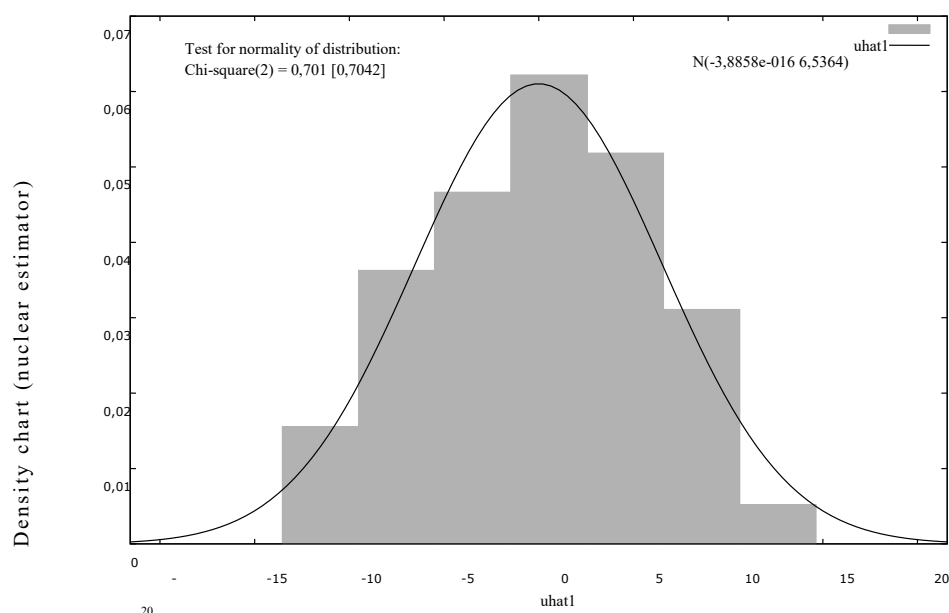
Asymptotic statistics: Chi-square(4) = 2,83326, with p value = 0,586105.

Panel residual variance = 34,7142.

unit	variance
1	48,7280 (T = 12)
2	36,3393 (T = 12)

3 29,5124 (T = 12)

4 24,2771 (T = 12)



**Fig. 2.** Test for normality of distribution [own elaboration based on the GRETL program].

The evaluation of the normality of the distribution was carried out using the Doornik-Hansen test, i.e. a test using the transformed value of skewness and kurtosis parameters.

In the next part of the analysis it was decided to work out the frequency distribution (Table 3) and make the alignment assessment.

**R-squared determination coefficient** = 0,856305.

Test statistics:  $TR^2 = 41,102638$ ,

with p value =  $P(\text{Chi-square}(38) > 41,102638) = 0,336254$ .

**Frequency distribution** for uhat1, observations 1-48, number of intervals = 7, mean = -3,88578e-016, standard deviation = 6.53645.

**Table 3.** Frequency distribution [own elaboration based on the GRETL program].

Intervals	Average	Number	Frequency	Cumulated	
< -9,5064	-11,518	3	6,25%	6,25%	**
-9,5064 - -5,4838	-7,4951	7	14,58%	20,83%	*****
-5,4838 - -1,4612	-3,4725	9	18,75%	39,58%	*****
-1,4612 - 2,5614	0,55006	12	25,00%	64,58%	*****
2,5614 - 6,5840	4,5727	10	20,83%	85,42%	*****
6,5840 - 10,607	8,5953	6	12,50%	97,92%	****
>= 10,607	12,618	1	2,08%	100,00%	

Null hypothesis: an empirical distributor has a normal distribution.



The Doornik-Hansen Test (1994) - transformed skewness and kurtosis:  
Chi-square (2) = 0.701, with a p value of 0.70424.

Another very important issue in econometric modeling is the study of the collinearity of explanatory variables. This is extremely important, because the possible collinearity of variables is an undesirable feature. Because if there is an exact collinearity, the model will not be estimated because the determinant of the  $X^T X$  matrix is zero. The high correlation of explanatory variables causes that the determinant value is close to zero, thus the standard errors of parameter evaluations, derived from the variance and covariance matrix, have relatively large values, which in turn leads to understating the value of Student's t-statistics in the parameter significance assessment. If the value of  $VIF_j$  equals one, it means that the variable  $x_j$  is uncorrelated in relation to the other explanatory variables of the model. A dramatically different situation occurs when  $VIF_j > 10$  then it is a sign of collinearity, which significantly disturbs the quality of the analyzed model [15].

**Collinearity Rating VIF (j) - factor of variation distortion:**

VIF (Variance Inflation Factors) - the minimum possible value = 1.0.

Values greater than 10.0 may indicate a collinearity problem - distortion of variance.

$X_{1it}$  - 1,227;  $X_{2it}$  - 1,383;  $X_{3it}$  - 1,293;  $X_{4it}$  - 1,036;  $X_{5it}$  - 1,052; Cz - 1,701; H - 1,564; P - 1,576.

The results indicate that there is no collinear problem in the model under study because all tested values are less than 10.

$$VIF(j) = 1/(1 - R(j)^2),$$

where  $R(j)$  is the multiple correlation coefficient between the variable 'j' and the other independent variables of the model.

Matrix features  $X'X$ : 1-norm = 88,267132, determinant = 0,0016567627, indicator of the conditioning of the CN matrix = 2,2254459e-005.

The next stage of the panel model research was devoted to taking into account individual effects, which can be twofold, which is why they are divided into fixed effects and random effects. However, due to the breadth of the proposed analysis, it was decided to limit only to the study of established effects. The results obtained are shown in Table 4.

**Table 4.** Estimated effects (non-random effects) taking into account the diversity of the free expression according to units in the cross-section, [own elaboration based on the GRETL program].

	Coefficient	Standard error	p value	
const	2,8682	1,4041	0,04789	**
X1it	39,991	17,109	0,02464	**
X2it	39,553	17,378	0,02842	**
X3it	8,0184	10,75	0,46020	
X4it	-401,12	144,45	0,00839	***
X5it	172,85	108,15	0,11807	
The arithmetic mean of the dependent variable	5,189866	Standard deviation of a dependent variable	7,430614	

The sum of residual squares	1666,281	Standard error of residues	6,536449
LSDV R-square	0,357902	Within R-square	0,325046
LSDV F(8, 39)	2,717303	The p-value for the F test	0,017578
Logarithm of credibility	-153,2406	Akaike information criterion	324,4812
Schwarz Bayesian criterion	341,3220	Hannan-Quinn criterion	330,8454
Autocorrelation of residues - rho1	-0,078460	Durbin-Watson statistics	2,004700

4 group mediums including data:

Residual variance:  $1666,28 / (48 - 9) = 42.7252$ .

Total significance of grouped inequalities:

$F(3, 39) = 0$ , with the value of p 1.

A low p value means rejecting the H0 hypothesis that the LSM panel model is correct, against the H1 hypothesis, that the model with the determined effects is more appropriate.

Average residuals for section units in the LSM panel estimation:

unit 1:  $1,4803e-015$

unit 2:  $6,6613e-016$

unit 3:  $2,3685e-015$

unit 4:  $-5,9952e-015$

It should be noted that in order to determine whether a given panel model can be estimated using LSM, one should verify the hypothesis about the existence of an individual effect or, concurrently, whether the variance of the individual effects component is equal to zero. Breusch-Pagan's test serves this purpose.

#### **Breusch-Pagan test statistics:**

$LM = 2.18182$  with the value of p = probe ( $\chi^2(1) > 2.18182$ ) = 0.139649.

A low p value means rejecting the H0 hypothesis that the LSM panel model is correct, against the H1 hypothesis, that the random effect model is more appropriate.

## **Summary and Conclusions**

After the analysis, it can be concluded that the chosen model is suitable for forecasting. Because the share of the standard error of the residues to the arithmetic mean of the dependent variable does not exceed 10%.

After analyzing the value of the coefficients of determination to the minimum value adopted from above, it can be stated that the tested model has a high fit.

The distribution of residues is consistent with the normal distribution, moreover, the constructed model does not contain autocorrelations of residues.

The relationship between variables is linear.

In addition, on the basis of the arguments quoted below, it is considered that the specificity of the model is correct because:

- a set of explanatory variables was selected appropriately;
- there is correctness of the functional form;
- zero-one variables were used.

To sum up, the aim of the research was to identify statistically significant determinants of innovation affecting the economic growth of the V4 countries. Therefore, an analysis of the relationship between selected variables regarding the level of innovation and changes in economic growth in 2005-2016 was conducted. A panel model was built, using annual data describing four selected for analysis states. The estimation of the model was made using the classic least squares method using the GRETl program.

The results of the analysis presented in the paper allow to formulate the following conclusions:

- panel analysis is useful for solving problems related to the search for determinants shaping economic growth in the V4 countries;
- a statistically significant variable with a 0.01 significance level turned out to be a variable unemployed with a higher education of 10,000. residents;
- two variables should be included in the factors determining the determinants of economic growth in the analyzed countries: X1it - internal expenditures on R & D of the enterprise sector and X2it - internal expenditures on R & D of the government sector. The increase in the level of these variables has a positive impact on economic growth in the Visegrad Group countries. This identification makes it possible to improve national policies and to focus actions on those that most significantly improve the socio-economic situation of the V4 countries;
- the variables X1it and X2it had a statistically significant effect on the change in the level of economic growth, with the X4it variable having a stronger impact on the shaping of the explained variable;
- the zero-one variable for Hungary turned out to be a statistically variable being at the significance level of 0.1.

## References

1. Beugelsdijk, S., Brakman S., Garretsen, H., Marrewijk, Ch.: International Economics and Business Nations and Firms in the Global Economy, pp.392-408. Cambridge University Press, Cambridge (2014).
2. Biea, N.: Econometric Growth in Slovakia: Past Successes and Future Challenges. EU Economic Brief, No. 008. Luxembourg: Publications Office of the European Union (2006).
3. Brożek, K., Kogut, J.: Ekonometryczna analiza zarządzania działalnością B+R w polskich przedsiębiorstwach. Education of Economists and Managers no 2(44) 2017 pp. 145-160 (2017).

4. Bukowski, S.I., Garlińska-Bielawska, J.: Eksport do Niemiec jako czynnik wzrostu gospodarczego w Polsce w latach 2000-2012, *Acta Universitatis Lodzensis Folia Oeconomica*, Lodz (2014).
5. Bywalec, C.: Konsumpcja a rozwój gospodarczy i społeczny, p. 61. Wydawnictwo C.H. Beck, Warsaw (2010).
6. Chao, X.: The Dynamic Evolution of the Distribution of the Quality of Economic Growth in China: 1998-2014, pp.310-317. In: *Hradec Economy Days 2017 vol. 7 (1)*, University of Hradec Králové, Hradec Králové (2017).
7. Dymitrowski, A.: The Role of Innovations. Created in the Internationalization Process for Company Performance, pp. 95-120. PWN, Warsaw (2014).
8. European Statistical Office, <https://ec.europa.eu/eurostat>, last accessed 2018/08/10.
9. Franc-Dąbrowska, J.: Praktyczne zastosowanie wybranych modeli panelowych do oceny sytuacji finansowej przedsiębiorstw rolniczych, <https://wne.sggw.pl>, last accessed 2018/11/26.
10. Gnypowa, B. (eds.): Zrozumieć wzrost gospodarczy. Analiza na poziomie makroekonomicznym, poziomie branży i poziomie firmy, pp. 19, 87. Oficyna Ekonomiczna, Cracow (2005).
11. Górecki, B. R.: Ekonometria podstawy teorii i praktyki, p. 17. Wydawnictwo Key Text, Warsaw (2013).
12. Kang, M.: Factor analysis and quality evaluation for economic growth with investment-growth model. *The Journal of Quantitative & Technical Economics*, (2) pp. 153-160 (2006).
13. Korez-Vide, R. & Tominc, P.: Competitiveness, Entrepreneurship and Economic Growth. In: P. Trąpczyński, L. Puślecki, M. Jarosinski (Eds.), *Competitiveness of CEE Economies and Businesses*, pp. 25-44. Basel. Springer International Publishing AG (2016).
14. Kowalska, A., Kovárník, J.: The Innovativeness and Competitiveness of the Visegrad Group Countries in the years 2011-2016 - Selected Indicators, pp. 460-470. In: *Hradec Economy Days 2018 vol. 8 (1)*, University of Hradec Králové, Hradec Králové (2018).
15. Kufel, T.: Ekonometria, Rozwiązanie problemów z wykorzystaniem programu GRETLL, Wydanie trzecie zmienione, p. 33, pp. 57-58, pp. 64-65, p. 173. Wydawnictwo Naukowe PWN, Warsaw (2013).
16. Marakova, V., Dyr, T., Wolak-Tuzimek, A.: *Factors of Tourism's Competitiveness in the European Union Countries*. In: *Ekonomika a Management 2016 no. 3*, pp. 92-109 (2016).
17. Masoud, N., A contribution to the Theory of Economic Growth: Old and New. *Journal of Economics and International Finance*, 6(3), pp. 47-61 (2014).
18. Meyer, N., Jongh, J.: Entrepreneurial Activity and Its Relationship to Economic Growth and Development: A Comparative Study between Slovakia and Poland, In: M. Frankovsky, J. Dobrovic, R. Fedorko (Eds.), *Management and the World in Motion, Challenges, Opportunities and Threats*, Bookman s.r.o., Presov (2018).
19. Meyer, N., Meyer, D.F. An Econometric Analysis of Entrepreneurial Activity, Economic Growth and Employment: The Case of the BRICS Countries. *International Journal of Economic Perspectives*, Vol. 11(2), pp. 429-441 (2017).
20. Özcelik, E., Taymaz, E.: Does Innovativeness Matter for International Competitiveness in Developing Countries? The Case of Turkish Manufacturing Industries. *Research Policy* 33(1), pp. 409-424 (2004).
21. Sipa, M.: Diversification of Indexes Determining Innovation of Economies – The Visegrad Group Countries. In: *Hradec Economy Days 2015 vol. 5*, University of Hradec Králové, Hradec Králové (2015).

## How is Corporate Social Responsibility Meant: Analysis of 100 Definitions

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**Abstract.** One of the ways how to boost competitiveness is to use the Corporate Social Responsibility (CSR) concept. The term "Corporate Social Responsibility", although it is discussed for more than half a century, currently has no universally applicable and uniform global definition. The aim of the paper is to analyze one hundred definitions from different authors, to find the most common words in them and to create a universal definition. According to literature review, social responsibility is based on volunteering, stakeholders and integration of individual pillars. Pillars are supposed to be economic, social, environmental, legal, philanthropic and ethical. However, volunteering is currently on thin ice due to the European Union regulation.

**Keywords:** Corporate Social Responsibility, Definition, Voluntary.

### 1 Introduction

The present time is characterized by constant and rapid changes. This development dynamics brings many challenges but also the challenges faced by management. Due to the highly turbulent business environment, achieving, shaping, and above all, maintaining the competitiveness of an enterprise with a very challenging task.

One of the ways how to boost competitiveness is to use the Corporate Social Responsibility (CSR) concept. This topic is being increasingly discussed. The competitors and the community are more interesting in company's behaving to their clients, environmental and social, staff and to the needs of community. Prosperous enterprises do not concentrate only on making profits. Interest in social responsibility is highly increasing in the Czech Republic, and the number of companies using this concept is growing.

There are currently various competitions where social responsibility is measured according to various indicators. New interests and expectations are emerging from consumers, citizens and investors, growing interest in the impacts of economic activities on the environment, and media and modern communication technologies, including social networks, enforce the transparency of business activities.

## 2 Definition of Corporate Social Responsibility

### 2.1 Current Status

Social responsibility has been the subject of several studies over the last few decades [5,7,22]. It has evolved from the philanthropic activities of executives and has gradually become a valuable component of the management of all stakeholders [24,31]. Involvement in socially responsible activities permeates different types of businesses in different sectors and countries.

The term "Corporate Social Responsibility" or CSR, although it is discussed for more than half a century, currently has no generally and universally valid definition. In accordance with [16] it could be because CSR is based on voluntariness. The concept has no defined limits and there is a wide space for discussion and for a broad comprehension by various stakeholders. [27] states that the explanation of CSR has diverse meaning for diverse individual involved parties, who should be analyzed for their significance – see e.g. [29].

The aim of the paper is to present one hundred definitions from different authors, to find the most common words in them and to create a universal definition.

### 2.2 Literature Review

In the Table 1 there are analyzed several definitions of CSR.

**Table 1.** Definitions of corporate social responsibility.

<i>Author</i>	<i>Definition</i>
Carroll (1999)	<i>interconnection</i> of four core areas – <i>economic</i> , <i>legal</i> , <i>ethic</i> and <i>voluntary</i> (later <i>philanthropy</i> )
Franc et al. (2006)	an overarching concept that encompasses topics ranging from <i>environmental</i> protection to <i>employment rights</i> , anti-discrimination, community work, transparency to <i>socially</i> responsible investment policy
World Business Council for Sustainable Development (Kotler and Lee, 2005)	the continuous obligation of companies to act <i>ethically</i> and to strive for <i>economically</i> sustainable growth and supporting the improvement of the quality of life of <i>staff</i> and their family members equally local community
Marková (2011)	such an undertaking's activity in which the undertaking behaves responsibly beyond the <i>legal</i> standards, which is not uncommon but permanent
Business Leaders Forum (Kunz, 2012)	the <i>voluntary</i> obligation of enterprises to act responsibly in the context of their activities both in the <i>ekological</i> and in the <i>society</i> in which they deal
Kislingerová and Nový (2005)	one of the objectives of corporate governance, deals with the impact of business behavior on its surroundings and the whole of <i>society</i> ,

	and understands the firm as a sub-company that has certain tasks in the company
Kalousová (2005)	a concept that primarily emphasizes respecting business value levels - towards <i>staff</i> , <i>suppliers</i> , <i>clients</i> , etc., and to the <i>environment</i> in which companies operate and influence their business - the <i>environment</i> , <i>people</i> and <i>organizations</i> in the community
Commission of the European Communities (2001)	a concept in which companies <i>connect social</i> and <i>ecological</i> interests in their business activities and in their cooperation with their <i>stakeholders</i> on a <i>voluntary</i> principle
Kuldová (2010)	<i>voluntary</i> determination of high ethical standards, efforts to minimize negative impacts on the <i>environment</i> , care for <i>employees</i> , maintaining good admissions, and contributing to support the region in which they operate
World Business Council for Sustainable Development (1999)	the enterprise's obligation to secure the sustainable economic development, working with <i>staff</i> , their family members, the <i>local community</i> and <i>society</i> at large to better their life quality
European Union (Kunz, 2012)	<i>voluntary connection</i> of <i>social</i> and <i>ecological</i> attentions to day-to-day enterprise operations and connections with business <i>stakeholders</i>
Čaník et al. (2006)	the concept whereby the company <i>voluntarily</i> supposes co-responsibility for the welfare and sustainable expansion of modern society while awaiting to ensure profitability and <i>competitiveness</i>
Kunz (2012)	a modern business concept that formulates the company's focus on retentive goals and intervenes in all areas of the enterprises' activities, socially responsible companies, while working in their function, try hard not only to cover traditional <i>economic</i> objectives but also to satisfy the <i>social</i> and <i>ecological</i> aspects of their operations
Jakubíková (2013)	the <i>voluntary</i> enterprises' obligation to operate responsibly to the <i>environment</i> and the business in which they run
Petříková (2008)	all operations that fulfill all the <i>legitimate</i> requirements beyond and also the operations by which the enterprises try to comprehend and gratify all <i>stakeholders</i> in <i>society</i>
The Corporate Social Responsibility Newswire Services (Kotler and Lee, 2009)	<i>integrating</i> corporate practices and values in such a way that they include the interests of all <i>stakeholders</i> including <i>consumers</i> , <i>employees</i> , <i>investors</i> and the <i>environment</i>
Tetřevová (2017)	such behavior of <i>managers</i> and other <i>employees</i> of the company, which respects not only the <i>economic</i> and technical interests of the company but also the interests of all corporate <i>stakeholders</i> , being implemented <i>voluntarily</i> beyond the <i>law</i> and contractual arrangements and merging with all corporate activities

Jones (1980)	the term that companies have a commitment to component groups in <i>society</i> other than <i>stockholders</i> and beyond that ordered by <i>law</i> or union contract, marking that a limit can go beyond simple property
Putnová (2004)	such conduct of businesses when they take into consideration the necessities of their inside and outside <i>environments</i> to widely assist to the overall melioration of the condition of <i>society</i> both within and beyond their businesslike operations
Dytrt (2006)	the <i>voluntary integration</i> of <i>social</i> and <i>environmental</i> considerations in synergy with <i>stakeholders</i> in business activities

### 3 Methodology and Results

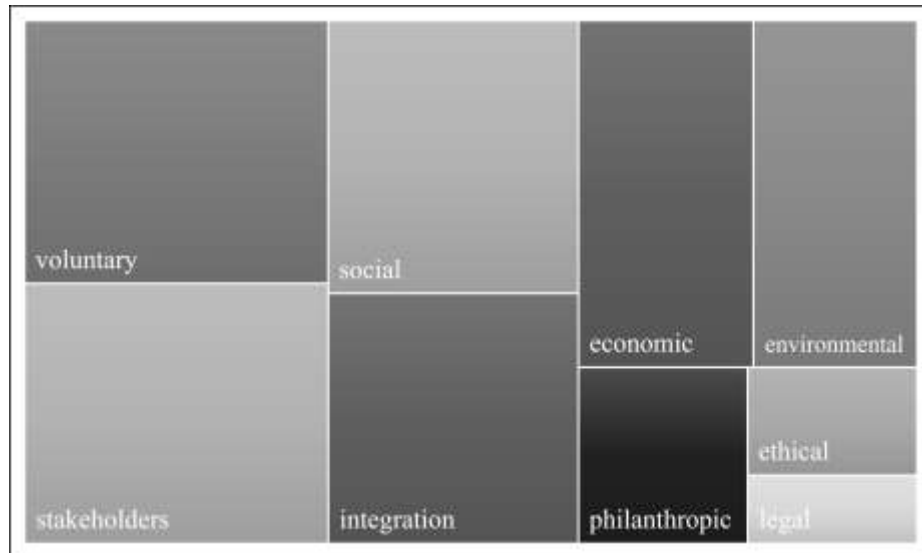
There were analyzed and then synthesized one hundred definitions of corporate social responsibility and found the most frequent words. The above definitions are by no mean a exhaustive bibliography of investigation on Corporate Social Responsibility definitions, but this paper illustrates the selection of methodological approaches used. Firstly, the definitions of CSR were assembled through the literature review. Secondly, these definitions were analyzed, and the most common words were determined. In the end, our own explanation of CSR was defined.

The most frequent words are highlighted in definitions mentioned above. We will consider some words as synonyms for simplification:

- economic = profits, competitiveness
- social = community, society,
- environmental = ecological,
- philanthropic = beneficent, charitable, community,
- legal = statutory, legitimate, rightful, law,
- voluntary = optional, beyond the law, unasked,
- integration = connection, interconnection, link, interaction,
- stakeholders = employees, suppliers, interested parties.

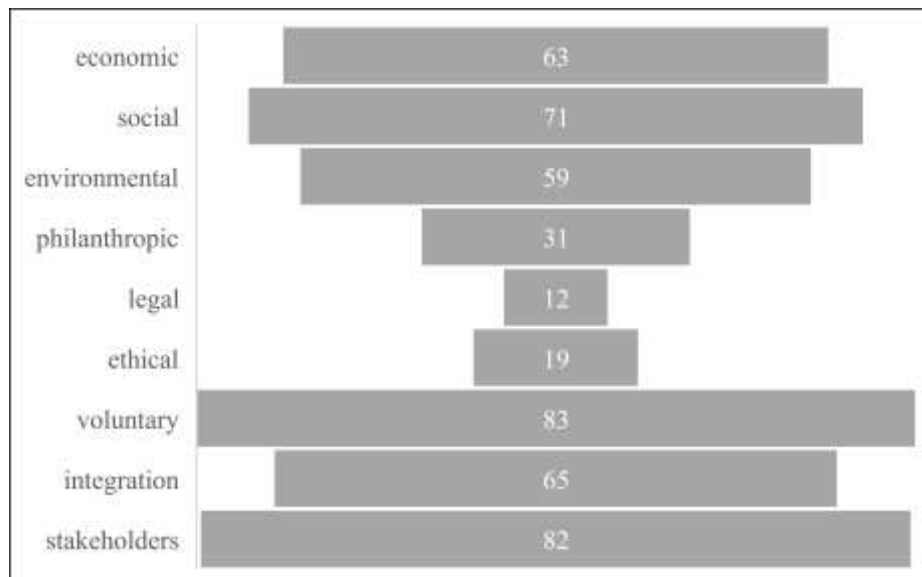
It was used a tool Tree map (see Fig. 1), which offers an interesting way to visualize a hierarchy of data. With it, data for different categories could be compared, such as the most common (frequent) words in definitions of CSR. The biggest part of tree map was filled with words voluntary, stakeholders, social and integration.





**Fig. 1.** Tree map of the most common words.

Another graph (see Fig. 2) shows the frequency of used words in definitions. The least used word is “legal” (12 %) and “ethical” (19 %). The most frequency pillar is “social” (71 %) and 83 % of authors think that CSR is based on voluntariness.



**Fig. 2.** Frequency of used words.

It was interesting to see if there are any correlations between words. Observations have revealed that if the word "environment" appears in the definition, the word "social" will often appear. If the word "philanthropic" appears in the definition, there is no word "legal" or "ethical".

Integration of various parts – economic, social, ecological/environmental, ethical, legal, etc., has various meaning by different authors. Some of them state that corporate social responsibility is based on only two or three pillars, some of them prefer more areas. This is based on how widely CSR is explained by authors. Theories about three parts (called three-bottom-line) include economic, social and environmental pillar and are comparable with socially responsible concept 3P, specifically people-planet-profit.

Using detailed examination, analyzing and then synthesizing the definitions from the literature review, the authors concluded that Corporate Social Responsibility (CSR) is an optional concept of socially responsible conduct beyond the legitimate commitments of the company that integrates the social, environmental and economic part and therefore it satisfies the objectives of all the interested parties.

## **4 Discussion**

Dalshrud [9] analyzed 37 definitions of CSR and resulted the five primary parts that were the most usual in the definitions (no less than 80%), but there is no mention of integration:

- environmental,
- social,
- economic,
- stakeholders,
- volunteering.

It can be argued that this paper focuses more complexly on definitions and is not limited to just five areas.

But is the concept of corporate social responsibility voluntary? Since 1st January 2017, large companies have a new legal obligation under EU Directive 2014/95/EU to make public their impact on society and the environment. This is so-called non-financial reporting.

Large enterprises covered by this obligation are enterprises with 500 or more employees, a net turnover of EUR 40 million or a balance sheet total of EUR 20 million and are public interest entities (governed by the law of a Member State and traded on stock exchanges, credit institutions and insurance companies).

Directive 2014/95/EU on the disclosure of non-financial information requires companies to disclose in their annual reports information relating to [21]:

- environmental areas,
- social and employment issues,
- respect for human rights,
- combating corruption and bribery,

- diversity and policies within the company's administrative, management and supervisory bodies.

The reporting itself can be based on several methodologies, the most complex of which are GRI and ISO 26000 pillars.

The objective of non-financial reporting is to achieve a higher level of transparency of social and environmental information provided by businesses in all sectors. Regular reporting should help businesses identify sustainability risks and increase consumer and investor confidence. Although this obligation does not apply to all companies, it could help improve access to responsible business as well as the right insight into CSR. CSR would no longer be voluntary in the case of a general obligation to report.

## 5 Conclusions

CSR, basically, is the economic, managerial, moral and in part political concept. It is a way for the management of the enterprise to take responsibility for the environmental and social impacts of their business activities.

The term "Corporate Social Responsibility" or CSR has no universally applicable and uniform global definition. Different authors have different meanings. In this paper one hundred definitions were analyzed. The most frequency words are voluntary (83 %), stakeholders (82 %), social (71 %) integration (65 %) and economic (63 %).

By detailed examination, analyzing and then synthesizing the definitions from the literature review, the authors concluded that Corporate Social Responsibility (CSR) is an optional concept of socially responsible conduct beyond the legitimate commitments of the company that integrates the social, environmental and economic part and therefore it satisfies the objectives of all the interested parties.

## References

1. Bowen, H. R.: Social Responsibilities of the Businessman. 1st edn. Harper and Row, New York (1953).
2. Čaník, P., Čaníková, P.: Aplikace metod a nástrojů podnikatelské etiky v českém podnikatelském prostředí. 1st edn. Transparency International - Czech Republic, Praha (2006).
3. Čaník, P., Řezbová, L., Zavřel, T.: Metody a nástroje podnikatelské etiky. 1st edn. Oeconomica, Praha (2006).
4. Carroll, A. B.: Corporate social responsibility – evolution of a definitional construction. *Business and Society*, 38(3): 268-295 (1999).
5. Carroll, A. B.: Corporate social responsibility. *Organizational dynamics*, 44(2), 87-96 (2015).
6. Carroll, A. B.: The Pyramid of Corporate Social Responsibility: Toward the Moral Management of Organizational Stakeholders. *Business Horizons*, 34(4), 39-48 (1991). DOI: 10.1016/0007-6813(91)90005-G.
7. Carter, C. R., Jennings M. M.: Role of purchasing in corporate social responsibility: a structural equation analysis. *The Journal of Business Logistics*, 25(1), 145-187 (2004).

8. Commission of the European Communities: Green Paper. Promoting a European Framework for Corporate Social Responsibility. 1st edn. Commission of the European Communities, Brussels (2001).
9. Dahlsrud, A.: How corporate social responsibility is defined: an analysis of 37 definitions. *Corporate social responsibility and environmental management*, 15(1), 1-13 (2008).
10. Dytrt, Z.: *Dobré jméno firmy*. 1st edn. Alfa Publishing, Praha (2006).
11. Frederick, W., Post, J., Davis, K. E.: *Business and Society. Corporate Strategy, Public Policy, Ethics*. 7th edn. McGraw-Hill, London (1992).
12. Friedman, M.: The social responsibility of business is to increase its profits. *The New York Times Magazine*, (September 13), 122-126 (1970).
13. Greening, D. W., Turban, D. B.: Corporate social performance as a competitive advantage in attracting a quality workforce. *Business & Society*, 39(3), 254-280 (2000).
14. Griffin, J. J., Mahon, J. F.: The corporate social performance and corporate financial performance debate: Twenty-five years of incomparable research. *Business & society*, 36(1), 5-31 (1997).
15. Johnson, G., Scholes, K., Whittington, R.: *Exploring Corporate Strategy*. 1st edn. Pearson Education limited, Harlow (2006).
16. Kašparová, K., Kunz, V.: *Moderní přístupy ke společenské odpovědnosti firem a CSR reportování*. 1st edn. Grada, Praha (2013).
17. Khoury, G., Rostami, J., Turnbull, J. P.: *Corporate Social Responsibility: Turning Words into Action*. 1st edn. Conference Board of Canada Ottawa (1999).
18. Kilcullen, M., Kooistra, J. O.: At least do no harm: sources on the changing role of business ethics and corporate social responsibility. *Reference Services Review* 27(2), 158-178 (1999).
19. Kotler, P., Lee, N.: *Corporate social responsibility: doing the most good for your company and your cause*. 1st edn. Hoboken, N.J., Wiley (2005).
20. Kunz, V.: *Společenská odpovědnost firem*. 1st edn. Grada, Praha (2012).
21. Kutlák, J.; Taušl Procházková, P.: Komunikace CSR aktivit: CSR reporting. *Trendy v podnikání*, 7(2), 63-74 (2017).
22. McWilliams, A., Siegel, D.: Corporate social responsibility: a theory of the firm perspective. *The Academy of Management Review*, 26(1), 117-127 (2001).
23. Moir, L.: What do we mean by corporate social responsibility? *Corporate Governance*, 1(2), 16-22 (2001).
24. O'Dwyer B.: Conceptions of corporate social responsibility: the nature of managerial capture. *Accounting, Auditing and Accountability Journal*, 16(4), 523-557 (2002).
25. Petříková, R.: *Společenská odpovědnost organizací*. 1st edn. DTO CZ, Ostrava (2008).
26. Piacentini, M. G., MacFadyen L, Eadie, D. R.: Corporate social responsibility in food retailing. *International Journal of Retail and Distribution Management*, 28(10), 459-469 (2000).
27. Pokorná, D.: *Koncept společenské odpovědnosti: obsah, podstata, rozsah*. 1st edn. Univerzita Palackého, Olomouc (2012).
28. Slabá, M., Fiala, R.: Application of Power-interest Matrix and Influence-attitude Matrix in Stakeholder Mapping of Universities. In: Špalková, D., Matějová, L. (eds.), *Proceedings of the 18th International Conference Current Trends in Public Sector Research*, pp. 318–326. Masaryk University, Brno (2014).
29. Tetřevová, L.: *Společenská odpovědnost firem společensky citlivých odvětví*. 1st edn. Grada Publishing, Praha (2017).

30. Van Marrewijk M.: Concepts and definitions of CSR and corporate sustainability: between agency and communion. *Journal of Business Ethics*, 44(2-3), 95-105 (2003).
31. Van Marrewijk M.: *The Concept and Definition of Corporate Social Responsibility*. 1st edn. Triple Performance Center, Amsterdam (2001).
32. Welford R, Frost S.: Corporate social responsibility in Asian supply chains. *Corporate Social Responsibility and Environmental Management*, 13(3), 166-176 (2006).
33. World Business Council for Sustainable Development: *Corporate Social Responsibility*. 1st edn. Conches-Geneva, Geneva (1999).

## Strategies of Knowledge Sharing in Farms Keeping Conservative Breed Livestock

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**Abstract.** The purpose of the study was to classify farms maintaining conservative breed livestock in terms of strategies of knowledge sharing with institutions. Data from 145 farms from south-eastern Poland was collected with a questionnaire in 2017. The strategies were determined on the basis of an IPA analysis.

The results show that Polish farmers implement livestock biodiversity protection programmes and create most numerous relationships with industry associations and advisory institutions. The subject of exchange in such relationships is knowledge and the largest quality gap is that of the farms following the concentration strategy (high importance and low intensity). Polish farmers implement the livestock species biodiversity protection programme creating most numerous relationships with industry organisations and advisory institutions. The object of sharing in these relationships is knowledge which indicates the existence of a continuous need to educate and adjust the training scope by institutions supporting agriculture. The role of institutions in supporting the biodiversity development processes is constantly increasing.

**Keywords:** IPA Importance Performance Analyse, Breeders, Knowledge Exchange.

### 1 Introduction

The Agricultural sector strongly needs to create, share and disseminate up-to-date and appropriate knowledge and information [7]. Recently, the concept of information sharing has attracted the attention of scholars, the most recent work was on the effect of information and knowledge sharing on performance [10]. Various scholars [4] argue that there are many factors enhancing value chain performance in addition to information sharing including trust and interaction. Trust depends to a large extent on information sharing and interaction.

Since the launch\* (2013) of the subsidies for the livestock conservative breed protection programme in Poland no major specialised platform for knowledge and

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\* Regulation of the Minister of Agriculture and Rural Development of March 13, 2013, item 361 on the specific conditions and manner of subsidization within the framework of the “Agricultural-environmental programme” covered by the Rural Areas Development Programme for the years

information sharing has emerged. Whereas Poland's public policy<sup>†</sup> is aimed at solving public problems related to economic development, social and environmental issues, there are still no effective solutions due to the delayed executive acts and their funding [12]. The efficiency of investments and innovation implementation in the scope of brokerage services (knowledge and information sharing) for breeders of livestock conservative breeds is still insufficient.

The breeders are left with conventional information channels which suggests that they typically work based on their own experience and experts' technical guidelines to determine which species are to be bred, for what products, how to associate with other producers and create economic networks. A large part of the knowledge base is in the experts' minds while individual breeders own it as concealed knowledge. There is a problem of a large amount of silent knowledge consisting in the fact that it is of a general nature, not species-specific (cattle, pigs, sheep, etc.). This is particularly important in a situation in which breeders are poorly organised. Also, no programme has been created that would support the organisation of this specific group of breeders implementing the biodiversity programme. The nature of breeding and the Polish regulations regarding food processing restrict the possibilities of marketing farm produce. Taking into account that animals are bred by small farms, their production scale and the ability to meet the quality requirements are limited in the light of strong competition on the part of breeders of traditional breeds and commercial network organisations. It is essential for the breeders of conservative breeds to cooperate in order to increase their development opportunities and change the existing approach. The breeders do not have full knowledge of the benefits the cooperation in groups brings, they are distrustful, and they do not take advantage of the opportunity to enter niche markets. In Poland, the consumers' interest in high-quality, certified food is increasing. Such production requires the breeders to expand their knowledge, e.g. by actively exchanging it with institutions such as Agricultural advisory centres, research institutes, industry associations.

Knowledge sharing traditionally by various courses should be combined with knowledge sharing via specialised websites. It follows from the research [6] that technical trainings for farmers are needed in the field of use of communication and information technologies that increase the transfer of information. Quick and global access to information and knowledge e.g. via ICT implies changes in the process of innovation which is based on recombination of the existing knowledge to increase the possibility of creating something new [1].

Small and medium companies (like farms) rarely have all the knowledge necessary for their effective management; in addition, the scope of essential knowledge changes with growth of the company [11]. Business consulting is characterised by diversity in relations to the content of services provided to companies of various sizes and the different stages development [8]. Owners like farmers are more likely to use other types of advisers instead of business consulting firm and professional consultants. They tend

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2007–2013. Package 7 of the said regulation refers to the conservation of endangered genetic resources in agriculture.

<sup>†</sup> A network for innovation and in rural areas was created in Poland (SIR), within the scope of the European Innovation Partnership.

to use business relations (friends, family) that do not perform advisory functions, such as accountants, suppliers, bank staff [3].

## **2 Methodology**

The purpose of research was to classify the farms with conservative breed livestock (cattle, sheep and pigs) in terms of how they exchange knowledge with institutions. Data from 145 farms in south-eastern Poland was collected with a direct interview questionnaire in 2017.

The study of the knowledge exchange was based on the assumption that it constitutes an act of providing of a specific service in which the farms are customers and the institutions are service providers. According to the network theory, a relationship occurs where there is common goal and exchange between entities occurs. The scope of exchange was narrowed down to knowledge due to the insignificance of other forms of exchange (material resources and skills). The knowledge of farmers keeping conservative breed livestock constituted, in turn, a guideline for estimation of educational and training needs (→ context of evaluation of social capital).

Assuming that the knowledge sharing relationships are services and that the causes determining the intensity and importance of knowledge sharing are complex, the IPA method used in the research of this kind was applied [9]. It allowed the relationship quality to be evaluated and the strategies of knowledge exchange to be classified. The extent of the gap between the evaluation of knowledge sharing intensity and their importance allows the “remedial” actions, such as: trainings, education, stimulation of relationship (meetings, trips) to be determined.

## **3 Results**

The studied farms created numerous relationships. Apart from customers and suppliers, economic relationships included: industry, advisory, scientific and state administration organizations (UM, UG, ARiMR, ARR) who the studied farms cooperated with. The results provided in this paper refer to the entirety of the relationships formed by farms, including all institutional entities.

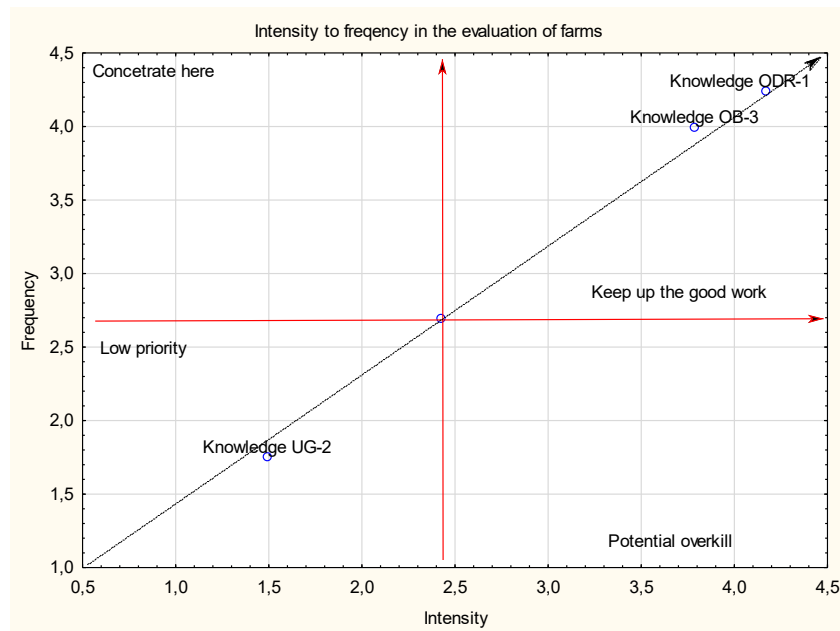
The concept of the IPA is based on the combination of four fields with results evaluation of intensity and the importance of given traits (any number of traits subject to evaluation). For the research presented in the paper, the importance and intensity were evaluated for the exchange of knowledge between farms with conservative breeds and the institutions they interact with. The score could range from 1 to 5. As a result of such arrangement of scores, average relationship scores were obtained based on knowledge exchange in four fields in the context of their importance and intensity (see Fig. 2). Each field means a different arrangement of scores (the proportion of importance to intensity). If the evaluation of intensity and importance was high (from 2.5 to 5), the relationship was in the field (f) of maintaining good relationships. In turn, if the importance and evaluation scores were low (from 0 to 2.5) the relationship was in the field of (d) trivialities. The analysis allowed the evaluations of importance and



intensity which define the quality gap to be compared. The higher the difference, the bigger the gap.

Intensity	>2,5 high <=5	<b>Concentrate here (g)</b> Little importance with a high implementation level	<b>Keep up the good work (f)</b> High importance with a high implementation level
	>0 low <2,5	<b>Low priority (d)</b> Little importance with a low implementation level	<b>Potential overkill (e)</b> High importance with a low implementation level
		>0 low <2,5	>2,5 high <=5
	<b>Importance</b>		

**Fig. 1.** Drawing of IPA analysis model.



**Fig. 2.** Importance versus frequency of knowledge sharing between farms and institutions (Agricultural advisory centres (ODR), Industry organisations (OB), Municipalities (UG)= local government institutions (UG)).

In the group of studied farms, the exchange of knowledge was of the highest importance for farms cooperating with industry organisations and agricultural advisory centres. These relationships were in the field of “keep up the good work” strategy. Conversely, knowledge sharing with municipalities was of little importance (see Fig. 2).

The most numerous form of relationship (73.10%) were d (field of trivialities) with a low importance and low intensity. The least numerous (2.76%) were g (excessive care) with little importance and a high intensity. The f relationships turned out to be popular (field of maintaining good position) (12.41%) with a high intensity and high importance which were handled according to the strategy typical for the field of trivialities (low importance and frequency of sharing; see: Table 1).

**Table 1.** Average scores of intensity and importance of knowledge sharing between farms and institutions in IPA fields.

Fields of IPA	Intensity (N)	Importance (M)	Gap (M-N)	Number of farms	IPA field per cent
d. Trivialities	1.27	1.39	0.12	106.00	73.10%
e. Concentration	2.02	2.90	0.88	17.00	11.72%
f. Maintaining a good position	2.80	3.03	0.24	18.00	12.41%
g. Excessive care	2.34	1.97	-0.38	4.00	2.76%
Average score	1.58	1.79	0.21	145.00	100.00%

A large gap in the field of concentration (e) means the necessity of committing training efforts in order to understand the development perspectives for farms due to knowledge sharing (Table 1).

The largest gap in the evaluation for field e (0.88) means the importance is higher than the intensity (relationships are not frequent but are important). In turn, frequent relationships with low importance occurred in field g (field of excessive care, see Table 1).

## 4 Discussion

Surely for the development of relationships between farmers, it must be determined what kind of knowledge they need (technological, market-related, coaching). There are premises for believing that certain variables define IPA strategies better (such as economic, relationship strength over time, % of produce procurement).

The results indicate that the Polish farmers implement the livestock species biodiversity protection programme creating most numerous relationships with industry organisations and advisory institutions. The object of sharing in these relationships is knowledge which indicates the existence of a continuous need to educate and adjust the training scope by institutions supporting agriculture. The role of institutions in supporting the biodiversity development processes is constantly increasing. The market problems faced by farms keeping conservative breeds require institutional support.

The largest quality gap was observed in the farms following the strategy of concentration (high importance and low intensity). The weakest relationships (low importance and low intensity – strategy of trivialities) were formed by a majority of farms (73.1%) with the lowest share of production under advance procurement contracts and low income.

The group of farms (12.41%) with the highest evaluation of relationships (high importance and high intensity – strategy of maintaining a good position) included entities with highest share of production under advance procurement contracts and high income.

## 5 Conclusions

In the context of biodiversity development, the farms following the strategy of maintaining a good position should be especially valued, while the farms following the strategy of trivialities should be monitored. The entities which do not value knowledge and sharing it, are at risk of being forced out of the market. The lack of knowledge restricts their access to advance procurement contracts and makes them miss the opportunity for profit (they do not know what, when and where they are missing).

**Acknowledgements.** The publication regards the BIOSTRATEG2/297267/14/NCBR/ /2016 project, funded by the National Centre for Research and Development under the Biostrateg programme entitled ‘Directions for the Use and Conservation of Livestock Genetic Resources in the Conditions of Sustainable Development.

## References

1. Arvanitidis, P. A., Petrakos, G.: Defining knowledge-driven economic dynamism in the world economy: A methodological perspective. In: Nijkamp P., Siedschlag I. (eds.) *Innovation, growth and competitiveness: Dynamic regions in the knowledge-based world economy*, pp. 15–39, Springer-Verlag, Berlin (2011).
2. Castells, M.: *Spółeczeństwo sieci*. 1st edn. PWN, Warsaw (2013).
3. Głodek, P.: *Zaufanie a źródła doradztwa małej firmy*. 1st edn. Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław (2017).
4. Grootaert, C., Bastelaer, T.: *The role of social capital in development: An empirical assessment*. 1st edn. Cambridge University Press, Cambridge (2002).
5. Hopp, W.: Trust, Trustworthiness, and Information Sharing in Supply Chains Bridging China and the United States. *Journal Management Science*, 60(10), 2435–2460 (2014).
6. Howland, F., Muñoz, L.A., Staiger-Rivas, S., Cock, J., Alvarez, S.: Data sharing and use of ICTs in agriculture: working with small farmer groups in Colombia. *Knowledge Management for Development Journal*, 11(2), 44–63 (2015).
7. Lotfi, Z., Mukhtar, M., Sahran, S., Zadeh, A. T.: Information sharing in supply chain management. *Procedia Technology*, 11, 298–304 (2013). DOI: 10.1016/j.protcy.2013.12.194.

8. Mole, K.F., Baldock, R., North, D.: Who takes advice? Firm size they should competence, concerns and informality in a contingency approach. *ECR Research Paper* 9, 9, 1–38 (2013).
9. Meng S., W., Nishimoto, H., Philip, G.: The Use of Importance-Performance Analysis (IPA) in Evaluating Japan's E-government Services. *Journal of Theoretical and Applied Electronic Commerce Research*, 6(2), 17–30 (2011).
10. Rashed, C. A. A., Azeem, A., Halim, A.: Effect of information and knowledge sharing on supply chain performance: A survey-based approach. *Journal of Operations and Supply Chain Management*, 3(2), 61–77 (2010).
11. Stawasz, E.: Rola doradztwa gospodarczego w zarządzaniu mikroprzedsiębiorstwami-wybrane oddziaływania i determinant. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, 419, 228–236, (2016). DOI: 10.15611/pn.2016.419.20.
12. Wiatrak, A.: The essence and conditions of brokerage services in the implementation of innovation in agribusiness. *Scientific Annals of the Association of Agricultural Economists and Agribusiness*, XX(4), 201–204 (2018). DOI: 10.5604/01.3001.0012.3062.

# The Application of IoT in the Area of Detection

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**Abstract.** The article presents the application of Internet of Things (IoT) technologies in the distribution of utilities. The presented application – detection of the integrity of seals of meters of certain utilities (water, gas or electric power) - is based on an extensive analysis of opportunities in applying the IoT principles to the distribution of utilities, in particular the distribution of electric power. One of the opportunities with rather high expectations from distributors is detection of the integrity of meter seals. The article includes a proposal of the technical solution of such an IoT application and discusses the cost-effectiveness of the solution. We have reached the conclusion that an isolated implementation of IoT technology is much more expensive than the currently used solution, which is based on labor and on having meters checked by people. Another way to increase the cost-effectiveness of IoT devices is to add the function of remote meter reading and its follow-up interconnection with data mining technologies and the evaluation of a large volume of data. However, this addition goes beyond the scope of this article.

**Keywords:** Internet of Things, Energy Industry.

## 1 Introduction

The potential of applications that are generally referred to as Internet of Things (IoT) has developed gradually – from its use in detecting the level of beverage cooling [6], to its application in systems with Radio-Frequency Identification (RFID) technologies [1] all the way to nowadays its very important role in the world of information and communication technologies (ICT). By the year 2013, IoT had developed into a system that combines a very big quantity of different technologies with various functions and uses different communication protocols. For instance, sensors, GPS and mobile equipment, devices monitoring the movement of equipment, their remote switching off or on, etc. The definition of IoT as a dynamic global network infrastructure, with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual “things” have identities, physical attributes and virtual personalities and use intelligent interfaces and are seamlessly integrated into the information system, has been generally accepted during the past two years [7].

One of the areas of implementation of IoT technologies is their use in the production, services and distribution of gas, potable water and electric power – utilities in general [4]. We have conducted a survey concerning the applicability of individual solutions in

this area from a technological and economic perspective [8]. This article focuses on one application opportunity only, which is the detection of broken seals of utility meters. Broken seals are a critical problem especially when it comes to major customers but often also when it comes to small customers [2]. A typical example is the use of this technology in the case of problematic customers who have tried to commit fraud in the past, as well as customers inclined to commit fraud based on data mining results.

Electronic seals with remote detection help to reduce or mitigate non-technical losses caused by ignoring the fact that the seals were broken or that the sealed sensor or a part thereof was tampered with until such a fact is detected [11]. Non-technical losses, also referred to as commercial losses, include e.g. un-metered fixed takeoffs, metering mistakes, billing or recording mistakes, incorrect meter installation, takeoffs below the sensitivity limit of electrometers, etc.

The application opportunity of electronic seals is based on the principle of metering the resistance wire [3]; if it is damaged, interrupted or short-circuited, the sensor will immediately send information about such damage through the IoT network [5]. The resistance wire is either placed next to the mechanical seal, provided that there is enough room, or is a part of the mechanical seal and is placed in the fixed insulation. The purpose is to monitor on-line any seal breaking at the site of all customers [2].

## **2 Problem Formulation**

The use of IoT in this industry is very topical. One of the important applications is monitoring whether or not seals on different devices, mainly on meters, have been broken [3]. The goal of this article is to propose and analyze the potential use of IoT solutions in monitoring the integrity of seals on meters of utilities (e.g. water, electric power, gas, etc.).

A similar principle can also be applied to other areas to detect the integrity of seals. For this reason, this is very topical because by solving this problem, companies may save a lot of money, mainly in case of dishonest customers.

## **3 Methodology**

The basic data identified for this article mostly come from an extensive survey among experts from the energy supply industry [12] in the Czech Republic [10]. The survey among 50 experts from different business companies and universities was conducted at the turn of 2016 and 2017.

To obtain relevant data, over 67 two-round workshops were conducted. The first round included 50 structured workshops, using questionnaires. Our questionnaires' for asking questions and identifying technologies for IoT and business opportunities were based on the technique of guided questioning, with the use of open and closed questions [9].

Once all 50 workshops were finished, we processed and evaluated the data from the questionnaires that helped us to combine any identified duplicate application opportunities and to create a set of unique application opportunities.

In the second round of 17 workshops, experts and academicians evaluated 124 identified application opportunities and assigned to them priority from 1 to 3, where 1 was the most important and 3 the least important in terms of implementation [8].

It is important to add that the list of identified opportunities may always change, depending on workshop participants and actual changes of information technologies in IoT.

## **4 Results**

A complete detailed overview of the results is provided and commented on in the article [8]. It is important to mention that we identified 16 application opportunities with priority 1, 20 application opportunities with priority 2 and 25 application opportunities with priority 3. The remaining 63 application opportunities were not assigned any priority due to differently evaluated factors, such as importance, costs, implementation speed, societal benefits, etc.

As already mentioned, in this article we focus on one of the application opportunities with priority 1, specifically on the implementation of the system detecting the integrity of seals [3].

The entire systematic solution for detecting the integrity of seals can be divided into five steps:

- Technical solution;
- Sensors;
- Communication in the IoT network;
- Work with data prior to transmission;
- Power supply.

### **4.1 Technical Solution – Description**

An electronic seal is a simple device that measures the resistance of the resistance wire. This resistance wire responds not only to its interruption but also to its short-circuit or crossover. It also responds to any attempt to break it by dropping it or tampering with it. Based on the aforesaid, we can say that the transmission of information about a broken seal does not require any major data flow (alarm message, daily heartbeat device – a heartbeat is a simple message that is regularly sent to confirm that the device is properly working). In view of this fact, a low-energy IoT network can be used for transmission [12]. The message is sent on a one-off basis – it is not a regular transmission.

### **4.2 Sensors**

A sensor means a general device that can be used to detect any seal tampering and that transmits information about a broken seal.

Different types of sensors can be used to detect a broken seal. One of them is a sensor that uses the resistance wire. The resistance wire can usually also recognize a short-circuit caused by a person trying to break the seal and to overcome its protection by causing a short-circuit on metering terminals.

A sensor can also be used to monitor several different circuits. Each of them is then monitored by a separate circuit with the resistance wire. In such a case, each circuit is connected to a single shared sensor and if the seal is broken, we know that it was broken on some of the connected circuits. However, we cannot tell which seal was broken. This is how we can secure several separate parts of metered devices. But it requires that the devices (seals) are not too far from each other. As an example, we can mention a breaker panel with circuit breakers on a floor in a block of flats or an office building. Let's assume that there are four apartments on one floor whose electrometers are in a shared breaker panel in the hallway. In such a case, it is possible to connect the seals on each of the four electrometers to one sensor. In the case that one of the seals is broken, we will know the location and will check only those four seals.

We propose e.g. SIGFOX as a transmission IoT network because, based on conducted tests, it is much more resistant against tampering than other low-energy IoT networks and also is the only network with sufficient all-state coverage (resistance citation).

What is also important about these solutions is that the device sends a heartbeat message with information about battery voltage both during transmission and in the idle state together with the chip temperature on a regular basis, usually every 24 hours. Another important part is the unique identification of the sensor (its ID). Every sent message is signed and encoded into a hash message by the algorithm AES128. This guarantees the integrity of the transmitted message.

### **4.3 Communication in the IoT Network**

The device in IoT networks usually does not register in the network when sending data. The device sends the message immediately upon the data transmission request. No confirmation of message receipt is usually required in the IoT network. The robustness and guaranteed likelihood of message delivery is achieved by the following mechanisms:

- The message is typically sent three times in a row. This minimizes the risk that the message will not be delivered;
- IoT networks are usually designed in a way to make sure that the sent message could be received by the maximum number of base stations;
- An identifier is automatically assigned to every message by a protocol implemented in the modem. The identifier is automatically escalated to easily and quickly find out that some message was not delivered. In such a case, the receiving device can generate a defined event and inform the user about lost data;
- In the case that no message from the end equipment is received for a certain time, the data receiving system can regenerate the event and forward it to the user in a standard way.



#### **4.4 Work with Data Prior to Transmission**

It is often discussed whether or not it is necessary to process the data prior to transmission. In the case of this type of message and communication, it is not necessary to process the data in any major way. A defined information message is transmitted from the sensor only if the status changes (a specific event occurs), e.g. the resistance wire is interrupted, the seal is tilted or opened, etc.

#### **4.5 Power Supply**

Power supply is another important parameter of IoT solutions. A battery is usually used for this type of sensor. Considering how it is used (sending a heartbeat message once every 24 hours), its useful life is at least 7 years. The device is designed as low-energy because it is independent of any external source of energy to ensure that the seal could not be tampered with during a power outage.

### **5 Discussion**

The survey among sensor manufacturers showed that the price of an IoT device with an electronic seal is about 2,500 CZK. The cost of device installation and operation in the given IoT network must be added to this price.

When speaking of costs, we must always take into consideration benefits, proceeds or the reduction of other related costs.

When there are no technologies or no technologies are used that inform the utility provider about a problem on the device, the device must be checked by a person. Let's assume that during a work shift one person can check 80 meters on average (10 meters per hour during an 8-hour work shift). It is an average value; more meters can be checked in a housing development in Prague than in the countryside where it takes several or even dozens of minutes to get from one meter to another.

Therefore, one person can check about 1,600 meters per month and thus about 19,000 meters per year. If we assume about 500,000 apartments, we will need at least 27 employees who will check and monitor the situation once a year. Considering the average wage in Prague, which is about 40,000 CZK, it amounts to 19 million CZK in annual costs (when considering the company's costs and disregarding bonuses). To this amount, we must add the employee's cost of transportation between metering stations and the ineffective loss of his time, etc. The annual costs will be about 25 million CZK.

If we implement seals for all users, the cost will be extreme. It will be about 1,5 billion CZK. Therefore, this solution does not seem profitable when considering the annual savings of about 20 million CZK (the checking of broken seals will continue). However, we must also take into account the potential savings resulting from a timely detection of fraud, the consequent cost of collecting the due amount or potential court fees and legal costs, etc. This part, however, is hard to estimate at this moment without having detailed knowledge of the data.

This situation could be resolved by a combination of advanced data analysis technologies and behavior pattern identification, based on which it would be possible

to identify the customer groups with a higher risk of fraud. In such a case, seals could be installed only on these devices, which would considerably reduce costs. There could be a marketing campaign communicating that the given company started using modern methods of detecting fraud and that these methods will be used for certain customer groups. This will raise general awareness about how easy it is to detect fraud, which will further reduce the potential risk of losses caused by fraud.

## 6 Conclusions

There are a lot of IoT devices that can be applied in different areas of human activities, e.g. an IoT device monitoring the movement of vehicles to prevent unnecessary trips, a device monitoring parking lot occupancy, a device monitoring excessive noise and many others.

In this article, we focused on one specific application opportunity, which is the use of IoT sensors to monitor the integrity of seals. Seals in general are devices that protect service providers against unauthorized use. It could be a provider of some utility, such as water, electric power or gas. In these cases, end customers have a meter with a seal installed to protect utility providers against unauthorized takeoffs.

In the context of our article, unauthorized takeoffs are identified thanks to a broken seal that is connected to a sensor. In case the seal is broken, the sensor will identify this fact and will alert the service provider. This way the provider is immediately informed about the problem and can appropriately respond.

The main benefits of these solutions are as follows:

- Immediate detection of a broken seal;
- Identification of the location where the seal was broken;
- Easy installation;
- Low operating costs;
- Low investment costs – seals can be installed only at the site of customers who - based on other analyses - were identified as potentially risky.

Negative factors include the limited useful life of the device, which is usually up to seven years thanks to the installed battery. This disadvantage is however compensated by the fact that e.g. water meters are replaced once every five years. Gas meters and electrometers are replaced about this often as well.

**Acknowledgements.** Paper was processed with contribution of long term support of scientific work on Faculty of Informatics and Statistics, University of Economics, Prague (IP 400040).

## References

1. Ashtone, K.: Ashton, K.: That 'Internet of Things' Thing. RFID Journal 2009. June 22. <https://www.rfidjournal.com/articles/view?4986>, last accessed 2018/10/26.
2. Childs, P.R.N.: Mechanical Design Engineering Handbook. Butterworth-Heinemann, (2014).
3. Dolan, P. J.: Mechanical Seal Review Fluid Sealing, pp. 413-427. Springer, Dordrecht (1992).
4. Doucek, P., Pavlíček, A., Luc, L.: Internet of Things or Surveillance of Things? In: Tjoa A.M. et al. (eds.), Proceedings of the 11th IFIP WG 8.9 Working Conference, CONFENIS 2017 Research and Practical Issues of Enterprise Information Systems, LNBIP, vol. 327, pp. 45–55. Springer, Cham (2018). DOI: 10.1007/978-3-319-94845-4\_5.
5. Espinoza, F., Maryska, M.: Low Power Wide Area Networks, Comparison in the Context of the Czech Republic. In: Doucek, P. Chroust G., Oškrdal V. (eds.), Proceedings of the 26th Interdisciplinary Information Management Talks IDIMT-2018 Strategic Modeling in Management, Economy and Society, pp. 65–72. Trauner Verlag Universität, Linz (2018).
6. Foote, K., D.: A Brief History of the Internet of Things, Data Education for Business and IT Professionals, <http://www.dataversity.net/brief-history-internet-things/>, last accessed 2018/11/10.
7. van Kranenburg, R.: The Internet of Things: A Critique of Ambient Technology and the All-Seeing Network of RFID. Institute of Network Cultures, Amsterdam (2008).
8. Maryska, M., Doucek, P., Nedomova, L., Sládek, P.: The Energy Industry in the Czech Republic: On the Way to the Internet of Things. *Economies*, 6(2), 1-13 (2018). DOI: 10.3390/economies6020036
9. Řezanková, H.: Analýza dat z dotazníkových šetření. 2nd ed. Praha: Professional Publishing, Czech Republic (2010).
10. Sládek, P., Maryska, M.: The Business Potential of Emerging Technologies in the Energy Industry, In: Doucek, P. Chroust G., Oškrdal V. (eds.), Proceedings of the 26th Interdisciplinary Information Management Talks IDIMT-2018 Strategic Modeling in Management, Economy and Society, pp. 57–64. Trauner Verlag Universität, Linz (2018).
11. Yibo E.F., Fengshou G., Andrew B.: A review of the condition monitoring of mechanical seals, In: Proceedings of the ASME 7th Biennial Conference on Engineering Systems Design and Analysis, pp. 179-184. American Society of Mechanical Engineers (ASME), (2004).
12. Yuan, H., Zhao, J., Li, Y., Zhang, J., Mei, N.: 2017 : Energy analysis of a subsea steam Rankine cycle for the subsea power supply. In: Caetano, N.D.; Felgueiras, M.C. (eds.), Proceedings of the 4th International Conference on Energy and Environment Research, ICEER 2017, pp. 444-449. Elsevier (2017).

## The Influence of the Labour Market on the Development of Creative Professions in Sector Creative

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**Abstract.** The aim of the article is to present the issue of creative professions in the context of their impact on the labour market. The diversity of occupations classified in creative professions and changes in the labour market, which at the same time influence the development of these professions, were indicated. In view of the above, an attempt was made to study the meaning and determinants of creative professions, which are so desirable in today's economy. In order to verify the goal presented in the article, focus tests have been carried out, in which the participants of the discussion were asked to express their opinions as to whether the labour market determines the development of creative professions, and what changes in economic policy would be needed to encourage the development of creative professions.

**Keywords:** Labour Market, Creative Professions, Sector Creative.

### 1 Introduction

Among the changes that have occurred in recent years in the labour market, the most important ones are: the increased mobility of employees in the uniform European market, the provision of telework, the increased competition in professions requiring creative skills and concentration of intellectual capital. This involves the performance of creative professions, the importance of which for the economies of the countries is increasing. Therefore, significant changes are noted, such as e.g. the development and constitution of the creative segment, the changes in the lifestyle of people performing creative professions, and in particular the pursuit of experiencing exciting experiences of a dynamic rather than static nature, the shifting of preferences from the consumption of traditional goods and services to the consumption of experiences.

Thus, the aim of the article is to present the issues of creative professions in creative cities in the context of the impact of the labour market on this phenomenon. The diversity of occupations classified in the creative professions and the changes in the labour market that affect the development of creative professions have been indicated.

## 2 Creative Professions and the Labour Market

The concept of creative capital, can be understood as a profession or the subject of the performed work. It is the so called professional rather than supply-side approach, which draws attention to the fact that creativity is associated with the performance of professional activities, and not with the product itself. An example is here the concept of the creative class presented by Richard Florida who says that next to the service class and working-class the creative class becomes a successive element of the social and professional structure. According to it, the success does not lie only in access to natural or financial resources, but also to talented human capital.

Richard Florida defined the creative class as a leading driving force behind the economic development of the cities. Within the framework of his concept he proposed a set of 3T factors that include: talent, technology and tolerance, which have a decisive impact on the establishment of the representatives of the creative class in a given place [2, 3, 4, 5]. According to Florida, the creative class is created by specific professional groups, including those forming the creative core, inter alia, scientists, engineers, artists, designers and architects, people associated with sport and media (their work involves solving as well as searching for problems) and creative professionals: managers, businessmen, financiers, lawyers, doctors, sales managers (professions requiring specialist knowledge) [2, 3]. Representatives of the creative class do the work, which is significantly associated with the creation of innovative solutions, products, theories and strategies applicable in many areas [8]. The basic distinguishing feature of the creative class is to be a much greater level of autonomy and flexibility at work. Unlike workers and service representatives, members of the creative class earn mainly on the basis of what they create, not on whether they perform tasks according to the imposed plan. In addition to the creative nature of the work, the representatives of the new class are also connected by certain common characteristics of lifestyles, which blur the rigid division between work and leisure time, because in many cases their professional activity is the same as the hobby [9].

The characteristic feature of the group of people engaged in creative professions is the strong commitment of its members to the activity in the professional field. In addition, for the development of artists and intellectuals the socio-economic environment factors are of key significance as they stimulate that segment of the labour market, as well as the forms of leisure and the identification of the expectations of this group against the surrounding reality. Relations between the segment of people performing creative professions and their influence on creating the image of their place of residence (usually cities, metropolises) foster the generation of innovations that in turn increase the value for all inhabitants of a given settlement unit. In this context, a creative segment (as in a big simplification this group of workers could be specified) consists of the people who contribute to the economic value through their creativity and creative activity not only in the labour market, but also in the sphere of consumption, purchasing behaviour in particular. It should be noted that when the segment of people performing creative professions is taken into account, it is not about its material but intellectual property and the value that it owns.

It turns out that some people who, according to Florida belong to the creative class, are becoming representatives of the so-called cognitariat, for which independence and lack of regular employment is not so much a choice as a necessity. On the one hand, representatives of creative professions designate trends in socio-economic development and promote new standards of employment. On the other hand, they often work in conditions of forced flexibility and imposed autonomy which once was the choice of artists, and today increasingly becomes the current norm. It is a different thing, when a flexible form of employment is a choice that gives someone the freedom to create, guarantees the independence and possibility to fulfil oneself in a design formula, and quite another when it creates a situation of uncertainty, in which professional life runs from one order to another one, delusively reminding full-time employment, although it does not guarantee the same security [9]. Even Richard Florida after years from the presentation of the definition of creativity, noted that the creative economy deepens the existing social division, it increases segregation and separation of social groups [11].

It must be added that not always creative professions should be classified into this group of professions, because they are not creative. There is “a gap of creativity”, i.e. many professions or specialties are not creative, or they are not oriented towards creating cognitive and/or aesthetic and/or pragmatic (utilitarian) values, both distinguished in the psychology of creativity and included in the reports on the economics of creativity [7], even though they are assigned to this group of occupations. If it is possible to assign a profession or specialty to one of these areas, the type of values created can be determined. It should be added that the types of these values (cognitive - the creation of truth, aesthetic - the creation of beauty or pragmatic - the creation of items for use) often co-occur.

Table 1 shows selected professions that are classified to the creative professions, but they are not creative, therefore they should be excluded from the creative area. An example of professions that should not be considered creative are, inter alia, doctors who deal only with treatment or the construction professions, because they do not have the features of creativity.

**Table 1.** Selected professions which should be included in the area of the creative economy.

<b>The area of the creative economy</b>	<b>Professions considered to be creative</b>	<b>Creative features found in the creative professions</b>	<b>Professions that should be excluded from the area of the creative economy</b>
Architecture	Architect, interior designer, landscape architect, architect of greenery inside buildings, surveyor, designer, designer, industrial designer	Aesthetic and pragmatic	Construction, such as: civil engineer, mechanical engineer, chemical engineer, mining and metallurgy engineer, electrical engineer, electronics engineer,

Physician	Doctors, dietitians, specialists in different fields such as: nutrition, cosmetology, psychotherapy of addiction	Research and development, for example within the work of the university teacher) - the creation of cognitive and utilitarian (creating new operational techniques and their application in practice) values	telecommunications engineer Doctors who mainly deal with treatment
Publishing industry	Computer typesetter, reproductive editor, phototypesetting operator, polygraph scanner operator, draftsman, printer operator of photocopiers, bookbinder, bookbinding machine operator	Reproductive character	In the publishing industry, professions and specialities are mostly of a reproductive nature, although they occur in the creative branch

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Despite inaccuracies in classifying creative professions, three groups of creative workers should be distinguished, the so-called creative trident [6], those:

- working simultaneously in creative and cultural sectors (e.g. dancer in a ballet),
- working in creative professions, but outside the creative sector (e.g. designer of refrigerators),
- working in the creative sector, but not in a creative profession (e.g. doorman in the theater).

It should be emphasised that in the European Union there is a steady increase in the share of self-employed people working in culture, entertainment and recreation as well as in film production, in telecommunications and software production, and also those involved in publishing and radio and television activities. The form of employment is one of the main criteria for segmentation of labour markets in the creative economy. The first labour market includes people employed on the basis of employment contracts, guaranteeing social insurance, financing tools and materials necessary at work, financial stability in the time needed to prepare a work, career development opportunities, paid holiday periods and other benefits. Self-employment for the majority of those working in creative sectors is sometimes a compulsion, which involves a decidedly lower quality of working conditions and a lack of income stability. As a consequence, the self-employed often become participants in the second creative labour market [10].

If the changes taking place in the labour market, the future of the labour market and the threat of automation and digitization are considered, some professions are slightly at risk because their performance is based on competences and skills that are difficult to capture in algorithms. These mainly include originality/creativity and social intelligence, as well as ability to act in a non-routine way. In other words, the least threatened by automation are professions in which creativity, ingenuity and the ability to create new ideas and enter into relationships with other people must be used. Creative professions, requiring unconventional action, are a safe direction of the development, as opposed to the professions based on repetitive and schematic activities [1]. It should be added that creative industries not only produce 4.2% of European GDP, but are also the third largest employer in Europe. In addition, they are one of the main sectors in which young people are employed, also during the recession, which demonstrates the high flexibility of this sector and a positive future [1].

### **3 The Influence of the Labour Market on the Development of Creative Professions in the Context of the Development of Creative Cities - Empirical Depiction**

The article presents the scope of the issues of the authors' own research. The study area of the presented subject matter includes the recognition of the discussed issues both on the theoretical (literature) and empirical (conducted focus group interviews) planes. Within the quantitative research Focus Group Interviews (FGI), commonly called focuses, were carried out. The aim of the focus research was the direct interaction of the researcher and the respondents, which fully meets requirements made by the author of the studies. The organization of the discussion groups turned out to be a difficult, but interesting task due to the specificity of their work.

The focus research progressed according to a defined "key of the study", that is, the scenario used by the interviewer. The questions asked were of an open character: the participants "made inquiries" about significant to the problem, potential threads emerging in the course of their statements. The studies of this kind have particular specificity, their results are analysed on the basis of the discussion transcripts - practically each important word uttered by respondents is analysed. The basic tool in the report from the qualitative research, is a quotation, therefore the report is full of quotations. Thus, we can get better acquainted with the studied issues.

On the basis of the application of appropriate scientific methods and procedures the concept of creative professions and labour market impact on their development was defined. This means that specific methods will be used in the research: analysis, synthesis, induction and deduction. The conclusion for the carried out research will be the answer to the following questions: "Does the job market, in the opinion of the respondents, determine the development of the creative professions, the development of the creative industries? What changes in economic policy should be introduced so



that it would foster the development of creative professions and affect the development of creative sectors, including creative cities?”.

In connection with the above, the following hypothesis was put forward: In order that the labour market could foster the development of creative sectors and creative cities it should support the development of creative professions.

In qualitative studies, the focus group interviews, commonly known as focuses (FGI) were carried out. The discussion was carried out within the framework of which the phenomena connected with the issue of creative professions, creative sectors, including creative cities and the influence of the labour market on their development were analysed. Focus group interviews were conducted in the group of students in October 2018. In the group, people at the age of 28 to 44, who live and work at least 10 years in Szczecin were studied. The group consisted of 15 people (including 8 women). The participants of the discussion were employed in the creative sectors (advertising, media, higher education, publishing, IT).

Therefore, in the beginning, the participants of the discussion were asked about the role of creative professions as the value added generator in the aspect of obtaining economic benefits, including the development of creative industries and creative cities. In the studied group, people participating in the discussion indicated that this role was primarily defined as a source of innovation. One of the participants defined the role of creative professions as a source of economic development, progress and innovation. Another participant said that, in his opinion, there were always creative professions and they were decisive in the development, but formerly this issue was not mentioned in discussions and the role of these professions in the development in general or concrete sectors or cities was not indicated. The subjects asked what they understood by this role pointed to numerous examples of various innovations that were the result of the work of the representatives of creative professions. As examples, the subjects mentioned innovations, i.e. modern web applications, smart homes, possibility of electronic control of cars. Then the surveyed were asked with what branches they associated creative professions. Most answers concerned graphics, advertising, fashion, design. Definitely less rarely the discussion participants identified occupations associated with: painting, music, architecture. It is worth noting that even unconsciously, the participants classified the creative professions in terms of creating usable goods rather than outstanding works.

Then the participants of the discussion were asked with what they associated creative sectors and whether the space in which they live and work could be considered creative and conducive to the development of individual and collective creativity. In connection with this, the respondents were asked to finish the sentence: creative sectors are: the entities in which working people perform creative professions, people who create innovations; enterprises that create innovations which improve life. Only one of the participants said that: creative sectors are enterprises that create, inter alia, mass culture goods. Therefore, the participants were asked to indicate industries which could be classified to these sectors. Among the answers there were: innovative industry, architecture, advertising, IT, design, research institutions. Then continuing the discussion thread the respondents were asked which

activities they think develop best in their place of residence and work. Among the responses there were: advertising, innovative industry, programming.

The participants of the discussion were also asked whether their place of residence-the city and workplace could be considered creative and creating the space for the development of creative professions and creative sectors. Only 4 out of 15 people maintained that both the place of residence and work created the conditions for the development of creative professions, including their individual creativity. 2 people said that the workplace was a field in which they could develop their creativity and acquire new skills in creative professions, whereas 5 people answered that the place of residence only gave them such opportunities.

To the question whether in the opinion of the respondents the labour market in the city of Szczecin can influence the development of creative professions, the participants mainly answered that "the labour market determines the development of creative professions and creative sectors". In this connection, the participants in the discussion were asked why they thought so. The subjects answered that in the context of today's demands for innovation and rapid changes in global and local environment cause that there is a growing demand for these professions. In addition, one of the participants said "that these professions allow and support flexible work or the flexible labour market. In fact, they allow free disposing of working hours and their effect". Another participant of the discussion stated that "creative professions allow developing oneself, developing one's skills and thus creating more and more new spaces for the labour market, which are still not developed in the city of Szczecin".

In view of the above, another aspect of the discussion were the factors that the respondents would classify to those most important, conditioning the development of creative professions and thereby creative sectors in the context of labour market conditions. As the first factors the group listed: the demand for the representatives of creative professions, the demand of the local and national economy for services and products created as a result of the work of people representing creative professions, higher education teaching people representing creative professions, local initiatives supporting creative professions.

The participants of the panel were also asked to indicate the factors which, in their point of view, play the important role in the development of the creative professions, including efficiency of creative sectors. The group was to assign them an appropriate status indicating, on a 1 to 5 scale, the least important factor (1) to the most important (5). Initially, the subjects had a problem identifying their clear position, however, when some individuals began to list the determinants, others joined in the discussion. The result of the common analysis was to rank the factors according to the criterion of importance, from the least to the most important. This made it possible to prioritise distinguishing features as follows: the demand of the local and national economy for services and products created as a result of the work of people representing creative professions - 5, the demand for the representatives of creative professions - 4; local and national support for the development of creative professions - 3; local initiatives supporting the development of creative professions - 3; higher education training creative professionals - 2.

## 4 Conclusions

The employment growth in the creative sector is co-determined by the existence of the demand for its services and products (in the opinion of the respondents). Part of the creative industries cope very well with the creation of interest among a very diverse group of consumers (e.g. computer games industry). However, others require a recipient, better prepared for the perception of artistic productions, who wants to participate in culture, who is open to newness, who appreciates not only the utilitarian values, but also the aesthetic environment in which he/she lives.

Undoubtedly, the segment of people performing creative professions is a “motor” that stimulates economic growth by creating new forms, e.g. innovative solutions, creating products or also services. In addition, the representatives of this segment of the labour market play an important role in the national economy due to the large share in generating GDP and paying high taxes. The respondents confirmed claims appearing in the source literature that people who belong to creative professions are a group that generates innovations, thus affects competitiveness in this area. Thanks to this group of people representing these professions, development and progress are effectuated. Moreover, according to the respondents, it is necessary to create appropriate conditions in order that this particular group of professions could develop and create value added. Determinants that influence the development of creative professions in a given territorial area are: the demand of the local and national economy for services and products created from the work of people representing creative professions, the demand for representatives of creative professionals; local and national support for the development of creative professions; local initiatives in support of creative professions; higher education for representatives of creative professions.

## References

1. Citi GPS: Global Perspectives & Solutions. Technology at Work. The Future Is Not What It Used to Be, [http://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi\\_GPS\\_Technology\\_Work\\_2.pdf](http://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work_2.pdf), last accessed 2018/10/11.
2. Florida, R.: *Narodziny klasy kreatywnej oraz jej wpływ na przeobrażenia w charakterze pracy, wypoczynku, społeczeństwa i życia codziennego* (The birth of the creative class and its influence on transformations in the nature of work, leisure, society and everyday life). National Center of Culture, Warsaw (2010).
3. Florida, R.: Bohemia and Economic Geography. *Journal of Economic Geography* 2, 55–71 (2002), DOI: 10.1093/jeg/2.1.55.
4. Florida, R.: The Economic Geography of Talent. *Annals of the American Association of Geographers* 92, 743–755 (2002), DOI: 10.1111/1467-8306.00314.
5. Florida, R.: *The Rise of the Creative Class: And How It Transforming Work, Leisure, Community and Everyday Life*. Basic Books, New York (2002).

6. Higgs, P., Cunningham, S.: Creative Industries Mapping: Where have we come from and where are we going? *Creative Industries Journal* 1, 7–30 (2008), DOI: 10.1386/cij.1.1.7\_1.
7. Lipka, A.: Luka kreatywności (The creativity gap). *Ekonomia XXI wieku (Economics of the 21st century)* 2, 73–87 (2017), DOI: 10.15611/e21.2017.2.05.
8. Mazurek-Łopacińska, K., Sobocińska, M.: Zarządzanie kapitałem ludzkim w przedsiębiorstwie w kontekście rozwoju klasy kreatywnej (Management of Human Capital in an Enterprise in the Context of the Development of the Creative Class). *Zeszyty Naukowe Uniwersytetu Szczecińskiego. Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania (Studies and Works of the Faculty of Economic and Management Sciences)*, no. 39 (part 2) (2015).
9. Nowak, K.: Kreatywność - kreatywne zawody. Z prądem czy pod prąd? (Creativity - Creative professions. With the current or against it?), <https://beslow.pl/slow/kreatywne-zawody-z-pradem-czy-pod-prad>, last accessed 2018/10/12.
10. Zawadzki, K.: Praca i wynagrodzenia w gospodarce kreatywnej. Uwarunkowania – specyfika – ewolucja (Work and wages in the creative economy. Conditions - specificity – evolution). Wydawnictwo Naukowe Uniwersytetu Mikołaja Kopernika (Scientific Publisher of the Nicolaus Copernicus University), Toruń (2016).
11. Żakowska, M.: Florida: Do diabła z klasą kreatywną (Damn the creative class), <http://magazynmiasta.pl/2015/09/22/florida-do-diabla-z-klasa-kreatywna/>, last accessed 2018/10/11.

## Macro Effect of Corporate Social Responsibility: Based on the Perspective of the High Quality of Economic Growth

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**Abstract.** This paper interprets the theoretical mechanism of the relationship between corporate social responsibility and the quality of economic growth from micro-perspective, and gives an empirical test of the effect of corporate social responsibility on the quality of economic growth with the data of listed company's corporate social responsibility report rating score from 2010 to 2015. The results show that the improvement of corporate social responsibility will help to promote the development of regional the quality of economic growth. In addition, the corporate social responsibility will have a significant positive impact on the quality of economic growth only in the areas where the proportion of higher education population and tertiary industry accounts for second industry is relatively high and rural-urban income gap is smaller.

**Keywords:** Corporate Social Responsibility, The Quality of Economic Growth, Moderating Effect.

### 1 Introduction

Promoting the quality of micro products and services is the precondition of realizing high quality of macro-economic growth. Enterprises achieve effective operation through improving the quality of products and services, which can promote the transformation of economic development from quantity growth to quality growth and finally realize high quality of economic development at the macro level [1,5]. Therefore, solving quality problems of micro products and services has become the key to mitigating the contradiction between unbalanced and inadequate development and the people's ever-growing needs for a better life, realizing economic modernization, and promoting the development of high quality economy. While the core of improving the quality of products and services is to fulfill corporate social responsibility and consolidate and improve the system of social responsibility.

Therefore, based on the data of corporate social responsibility of listed companies from 2010 to 2015 issued by Hexun net, we make a theoretical and empirical analysis of the effect of corporate social responsibility on the quality of economic growth. The possible marginal contributions of this paper are as follows: Firstly, there is few study on the relationship between corporate social responsibility and the quality of

economic growth, so the paper links the two of them and interprets the functional mechanism of corporate social responsibility to the quality of economic growth from micro level. Secondly, the impact of corporate social responsibility on the quality of economic growth has not been systematically explained, so this paper systematically analyzes the impact of corporate social responsibility on the quality of economic growth from three dimensions that includes the stability of economic growth, welfare improvement and distribution of fruits and resource utilization and ecosystem cost. Thirdly, since there are differences in the conditions of economic growth in each province, so we introduce three adjustment variables that include the percentage of higher education population, rural-urban income gap and the industrial structure and analyze the influence of these adjustment variables on the relationship between corporate social responsibility and the quality of economic growth.

## **2 Literature Review and Hypothesis Development**

### **2.1 Corporate Social Responsibility**

Since American scholar Oliver Sheldon formally put forward the concept of corporate social responsibility in 1924, the research on corporate social responsibility has gradually developed in academia. Many scholars have defined corporate social responsibility from different perspectives by using different methods [4, 6, 8]. Among them, the responsibility for shareholders is mainly concerned with enterprise profitability and solvency. The responsibility for employees focuses on caring and safety training for employees. The responsibilities of suppliers, customers and consumers are mainly concerned with products quality and after-sales service. Environmental responsibility is mainly concerned with the input of enterprises in environmental protection and governance. Social responsibility focuses on income tax payment and public donations.

### **2.2 The Quality of Economic Growth**

Scholars at home and abroad mainly measure the quality of economic growth from the following two perspectives. Firstly, from a narrow perspective, they think that the quality of economic growth refers to the efficiency of economic growth. Secondly, from a broad perspective, they think that the quality of economic growth belongs to the category of value judgment, which has rich connotation and involves all kinds of aspects of social life [3]. This study uses Chao and Hui's definition of the quality of economic growth, which thinks that the quality of economic growth covers four aspects: the stability of economic growth, the structure of economic growth, the social welfare change and distribution of fruits of economic growth, and resource utilization and ecological environment costs.

### 2.3 Corporate Social Responsibility and the Quality of Economic Growth

Since reform and opening up, it is obvious that Chinese enterprises have developed fast, but many enterprises have made negative effects on socioeconomic development in the process of rapid expansion, such as production safety risks, lack of employees' rights and interests, violation of consumers' interests and serious environmental pollution, all of which have seriously affected the sustained and healthy development of China's economy [8]. Therefore, when our economy enters a new stage of high quality development, transforming the economic development pattern and enhancing the quality of economic development become the new normal [5], and then the fulfilling of corporate social responsibility has attracted more and more attention [9]. Fulfilling corporate social responsibility is not only concerned about the interests of stakeholder groups but also could promote the welfare of the whole society. Enterprises are required to stick to green development, pay attention to the quality of enterprise development, achieve the maximization of economic and social values, and undertake its own social obligations in the pursuit of profit creation, which has become the common expectation of the government and the public. So, fulfilling corporate social responsibility could standardize enterprise's operation behavior, optimize allocation of resources and ultimately improve the quality of macroeconomic growth by guiding the transformation of enterprises' micro level management mode. Therefore, we pose the following hypothesis:

H: The fulfillment of corporate social responsibility is conducive to improving the quality of economic growth.

## 3 Research Design

Considering the lagging effect of corporate social responsibility on the quality of economic growth and the superiority of the system GMM in dealing with dynamic panel data (can overcome heteroscedasticity and serial correlation), this paper intends to adopt the system GMM estimation to empirically test the influence of corporate social responsibility on the quality of regional economic growth in China.

### 3.1 Model Design

To test the hypothesis, the following models are constructed:

$$economic_{it} = \alpha_0 + \alpha_1 respo_{it} + \alpha_2 L.economic_{it} + \sum_i \alpha_i * Control_{it} + \varepsilon_{it} \quad (1)$$

$$economic_{it} = \beta_0 + \beta_1 \{share; staff; welfare; enviro; social\}_{it} + \beta_2 L.economic_{it} + \sum_i \beta_i * Control_{it} + \varepsilon \quad (2)$$

Among them,  $economic_{it}$  refers to the quality of economic growth. Core independent variables include corporate social responsibility ( $respo_{it}$ ), shareholder social

responsibility ( $share_{it}$ ), employee social responsibility ( $staff_{it}$ ), supplier, customer and consumer's rights responsibility ( $welfare_{it}$ ), environment responsibility ( $enviro_{it}$ ), and social responsibility ( $social_{it}$ ).  $L.economic_{it}$  represents lag phase of the quality of economic growth and  $Control_{it}$  refers to a series of controlled variables that affect the quality of economic growth, consisting of gross fixed assets ( $assets_{it}$ ), the elderly dependency ratio ( $elderly_{it}$ ), employment population ( $employ_{it}$ ), government public expenditure ( $public_{it}$ ), and value of non-state firms ( $private_{it}$ ).

### 3.2 Sample Selection and Data Sources

The paper uses social responsibility rating data of A-share listed companies in the Shenzhen and Shanghai stock markets between 2010 and 2015 as the initial research sample and eliminates listed companies labeled as ST and PT, left with 5396 sample observations. Then we take average values of corporate social responsibility rating data by year and province as proxy variable of corporate social responsibility for the province in the year and obtain 180 annual provincial observation values ( $30 \times 6$ ). The remaining data are from China Statistical Yearbook between 2010 and 2016. Variable definitions and instructions are detailed in Table 1.

**Table 1.** Variable definitions and instructions.

Variable symbol	Variable name	Variable description
<i>economic</i>	The quality of economic growth	The index of the quality of economic growth based on the paper[2]
<i>haorespo</i>	Corporate social responsibility	The average values according to year and province of total score of corporate social responsibility rating
<i>share</i>	Shareholder responsibility	The average values according to year and province of the score of shareholder responsibility in the evaluation system
<i>staff</i>	Employee responsibility	The average values according to year and province of the score of employee responsibility in the evaluation system
<i>welfare</i>	Customer and consumer's rights responsibility	The average values according to year and province of the score of supplier, customer and consumer's rights responsibility in the evaluation system



<i>enviro</i>	Environmental responsibility	The average values according to year and province of the score of environmental responsibility in the evaluation system
<i>social</i>	Social responsibility	The average values according to year and province of the score of social responsibility in the evaluation system
<i>assets</i>	Gross fixed assets	Gross fixed assets in each province/GDP
<i>elderly</i>	The elderly dependency ratio	Elderly population in each province/working adult population in each province
<i>employ</i>	Employment population	Employed persons in each province
<i>public</i>	Government public expenditure	Government public expenditure in province/GDP
<i>private</i>	Value of non-state firms	Value of non-state firms/GDP
<i>higher</i>	The higher education population	The higher education population in each province /China's total population
<i>income</i>	Urban-rural income ratio	Disposal income of urban residents in each province/rural net incomes in each province
<i>structure</i>	Industrial structure	The proportion of tertiary industry output value of second industry output value in each province

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## 4 Empirical Results

### 4.1 Regression Results of Corporate Social Responsibility and the Quality of Economic Growth in Total Samples

Regression results based on System GMM are shown in Table 2. It can be seen from Table 2 that the relationship between corporate social responsibility and the quality of economic growth is positively related in the 1% significance level, indicating that corporate social responsibility has a significant positive effect on the quality of regional economic growth. The empirical results also reveal a path mechanism for improving the quality of regional economic growth from micro-enterprise level. Shareholder responsibility is negatively related to the quality of economic growth, while employee responsibility, supplier, customer and consumer rights responsibility, and environmental responsibility are positively related to the quality of economic growth in the 1% significance level respectively, indicating that if enterprises only

consider maximizing shareholder's interests will have a negative impact on the quality of regional economic growth. These findings also reflect that the traditional financial management targets—maximization of the profit and the shareholder's wealth can no longer meet the requirements of improving the quality of economic growth at the present stage of China. As an economic organization, enterprises should also actively undertake social responsibility and pay attention to the interests of the internal and external stakeholders while pursuing economic benefits. Among other control variables, gross fixed assets is negatively related to the quality of economic growth in the 1% level of significant, indicating that excessive investment in fixed assets will lead to waste of resources, produce high energy costs, and reduce the quality of economic growth. The positive effect of value of non-state firms on the quality of economic growth passes a 1% significant level test, which may be because the investment activities of private enterprises are more complying with market mechanism and more conducive to the improvement of the quality of regional economic growth.

**Table 2.** Regression results of corporate social responsibility and the quality of economic growth in total samples SYS GMM).

Independent variables	model (1)	model (2)	model (2)	model (2)	model (2)	model (2)
<i>L1.economic</i>	0.9556*** (57.77)	0.9543*** (69.26)	0.9550*** (60.29)	0.9616*** (63.30)	0.9503*** (60.10)	0.9504*** (64.64)
<i>respo</i>	0.0061*** (2.70)					
<i>share</i>		-0.0076 (-0.88)				
<i>staff</i>			0.0285*** (3.24)			
<i>welfare</i>				0.0212*** (3.02)		

<i>enviro</i>					0.0135**	
<i>social</i>						-0.0044 (-1.04)
<i>assets</i>	-0.0042*** (-5.29)	-0.0042*** (-6.04)	-0.0038*** (-5.18)	-0.0039*** (-5.30)	-0.0039*** (-4.93)	-0.0043*** (-5.08)
<i>elderly</i>	0.0070 (0.87)	0.0028 (0.43)	0.0079 (1.02)	0.0037 (0.44)	0.0066 (0.88)	0.0042 (0.62)
<i>employ</i>	-0.00001 (-0.94)	-5.77e-06 (-0.30)	-0.00002 (-1.23)	-0.00003 (-1.39)	-0.00001 (-0.68)	-1.19e-06 (-0.06)
<i>public</i>	-0.0066 (-1.24)	-0.0072* (-1.85)	-0.0084* (-1.73)	-0.0042 (-0.82)	-0.0085* (-1.70)	-0.0092* (-1.87)
<i>private</i>	0.5280*** (3.28)	0.5952*** (3.99)	0.5220*** (4.11)	0.5936*** (3.59)	0.5121*** (3.86)	0.5265*** (3.56)
<i>_cons</i>	0.0033 (0.02)	0.2669* (1.82)	0.0877 (0.55)	0.0745 (0.43)	0.1631 (1.10)	0.2584 (1.56)
<i>AR(2)</i>	-1.5339 (0.1251)	-1.6227 (0.1047)	-1.5449 (0.1224)	-1.5621 (0.1183)	-1.5435 (0.1227)	-1.6258 (0.1040)
<i>sargan</i>	18.2040 (0 .1499)	22.3519 (0.0501)	18.4889 (0.1398)	18.3170 (0.1458)	19.2237 (0.1163)	22.2142 (0.0521)

*N* 150 150 150 150 150 150

Notes: Data is calculated by Stata14.0. z-values is in parentheses.

\*\*\*, \*\*, \* significant respectively at 1 percent, 5 percent, 10 percent level.

## 4.2 Further Discussion

The percentage of population with higher education, urban-rural income ratio and industrial structure has an important effect on the quality of economic growth. Therefore, according to the median value of percentage of population with higher education, urban-rural income ratio and industrial structure between 2010 and 2015, we divide total sample into six sub-sample, including areas with higher percentage of higher education population, areas with lower percentage of higher education population, areas with larger urban-rural income ratio, areas with smaller urban-rural income ratio, areas with higher proportion of tertiary industry in second industry and areas with lower proportion of tertiary industry in second industry.

According to Table 3, in different years, the quality of economic growth in areas with higher percentage of higher education population is obviously better than that in areas with lower percentage of higher education population. We can see that the average values of the quality of economic growth in regions with lower percentage of higher education population are negative from 2010 to 2012 and 2015, while the average values of the quality of economic growth in regions with higher percentage of higher education population are positive in years between 2010 and 2015. the quality of economic growth in regions with smaller urban-rural income ratio are clearly much better than that in regions with larger urban-rural income ratio in different years. The average values of the quality of economic growth in regions with smaller urban-rural income ratio are more than 1, while those in regions with larger urban-rural income ratio are negative. Moreover, compared to regions with lower proportion of tertiary industry in second industry, the quality of economic growth is significantly better in each year between 2010 and 2015. From 2010 to 2014, the quality of economic growth in areas with lower proportion of tertiary industry in second industry is negative, and that are positive in areas with higher proportion of tertiary industry in second industry.

**Table 3.** Vertical grouped comparison of the quality of economic growth.

group year	Lower percentage of higher education population	Higher percentage of higher education population	Smaller urban- rural income ratio	Larger urban- rural income ratio	Lower proportion of tertiary industry in second industry	Higher proportion of tertiary industry in second industry
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	<i>economic</i> mean	<i>economic</i> mean	<i>economic</i> mean	<i>economic</i> mean	<i>economic</i> mean	<i>economic</i> mean
2010	-0.0226	0.5102	1.5705	-0.4516	-0.3035	1.0720
2011	-0.4406	1.4376	1.7329	-0.4004	-0.3612	1.6546
2012	-0.1304	1.6221	1.5109	-0.3546	-0.2285	1.4772
2013	0.0718	1.0953	1.2808	-0.4623	-0.1056	1.3712
2014	0.1543	1.0144	1.2865	-0.3939	-0.0723	1.1003
2015	-0.2353	1.0426	1.3897	-0.4773	0.0171	0.9921

Notes: Data is calculated by Stata14.0.

Further, we still, by using system GMM, test the relationship between corporate social responsibility and the quality of economic growth through sub-samples regression analysis, on the basis of different sub-samples divided by the percentage of higher education population, the size of urban-rural income gap and the proportion of tertiary industry in second industry. According to Table 4, corporate social responsibility has no significant impact on the quality of economic growth in regions with lower percentage of higher education population, while corporate social responsibility has a positive impact on the quality of economic growth in the 1% level of significance at regions with higher percentage of higher education population. At the same time, the positive correlation between corporate social responsibility and the quality of economic growth passes a 1% significant level test in regions with smaller urban-rural income gap, but there is no significant effect of corporate social responsibility on the quality of economic growth in regions with larger urban-rural income gap. In areas with lower proportion of tertiary industry in second industry, corporate social responsibility has a negative but not significant impact on the quality of economic growth, the positive impact of corporate social responsibility on the quality of economic growth passes a 1% significant level test in areas with higher proportion of tertiary industry in second industry. The results show that the percentage of higher education population, the urban-rural income gap and the proportion of tertiary industry in second industry have a regulating effect on the relationship between corporate social responsibility and the quality of economic growth. The positive impact of corporate social responsibility on the quality of economic growth can only be significantly released in areas with higher percentage of the higher education population, smaller urban-rural income gap and higher proportion of tertiary industry in second industry.

**Table 4.** Regression results of corporate social responsibility and the quality of economic growth in sub-samples (SYS GMM).

Independent variables	Lower percentage of higher education population model (1)	Higher percentage of higher education population model (1)	Smaller urban-rural income ratio model (1)	Larger urban-rural income ratio model (1)	Lower proportion of tertiary industry in second industry model (1)	Higher proportion of tertiary industry in second industry model (1)
<i>L.economic</i>	0.8202*** (18.72)	0.9508*** (82.15)	0.9417*** (93.17)	0.7635*** (10.28)	0.8433*** (14.82)	0.9024*** (52.97)
<i>respo</i>	-0.0008 (-0.76)	0.0126*** (2.79)	0.0066*** (4.72)	-0.0008 (-0.48)	0.0010 (0.29)	0.0080*** (4.59)
<i>assets</i>	-0.0020* (-1.83)	-0.0055*** (-4.00)	-0.0092*** (-2.28)	-0.0016*** (-3.58)	0.00009 (0.12)	-0.0102*** (-8.79)
<i>elderly</i>	0.0549*** (9.90)	-0.0201*** (-3.22)	0.0028 (0.38)	0.0154** (2.34)	0.0425*** (5.64)	0.0012 (0.13)
<i>employ</i>	1.32e-06 (0.05)	-0.00004** (-2.46)	-0.00005*** (-4.98)	0.00003 (0.84)	-3.25e-06 (-0.10)	0.00006 (1.46)
<i>public</i>	-0.0095*** (-5.10)	-0.0057 (-0.92)	-0.0065 (-1.06)	0.0047 (1.13)	-0.0037 (-1.13)	-0.0050 (-1.09)
<i>private</i>	-0.0232 (-0.11)	0.5244* (1.94)	0.2662 (1.57)	0.5789*** (5.39)	-0.2134 (-0.92)	1.0958*** (-2.15)
<i>_con</i>	-0.2394 (-1.22)	0.3769 (1.12)	0.6339** (2.53)	-0.6054** (-2.34)	-0.2644 (-1.32)	-0.3654** (-2.15)
AR(2)		-1.2514 (0.2108)		-0.0327 (0.9739)		-1.2236 (0.2211)
sargan		14.3135 (0.3521)		11.7913 (0.5448)		19.0644 (0.1211)
N	70	80	81	69	70	80

Notes: z-values in parentheses.

\*\*\* p<0.01, \*\* P<0.05, \* p<0.1.

## 5 Conclusion

The relationship between corporate social responsibility and the quality of economic growth involves a major problem of building a realistic channel of improving the quality of economic growth. The results are as follow: Firstly, there is a positive

relationship between corporate social responsibility and the quality of economic growth. With the improvement of corporate social responsibility, the quality of economic growth also increases. Among them, shareholder responsibility has a negative effect on the quality of economic growth, while the improvement of employee responsibility, suppliers, customers and consumer's rights responsibility will enhance the quality of economic growth. Secondly, corporate social responsibility has a significant positive impact on the quality of economic growth in areas with higher percentage of higher education population, smaller urban-rural income gap or higher proportion of tertiary industry in second industry, which means that human capital, income distribution and industrial structure have a regulating effect on the relationship between corporate social responsibility and the quality of economic growth. Fourthly, among other controlled variables, the over-investment of fixed assets is not conducive to sustainable high economic growth, while the development of private enterprises could improve the quality of economic growth.

Nowadays, China is in the critical stage of changing the mode of economic development. In order to solve the contradiction between the growing needs of our people and the state of unbalanced and inadequately development, we must firmly promote high quality development and realize economic development from the expansion of quantity to the improvement of quality. Based on this, this paper puts forward the following policy suggestions: (1) We find that corporate social responsibility has a significant positive effect on the quality of economic growth, which shows a micro path of improving the quality of economic growth, fulfilling corporate social responsibility. (2) Considering the fact that the current financial management goal of "maximizing profit and shareholder wealth" could not meet the requirements of high quality economic development in the new era of China, enterprises needs to establish a management mechanism of altruistic symbiosis and pay more attention to corporate social responsibility, especially employee responsibility, supplier, customer and consumer rights responsibility and environmental responsibility, which will provide positive contribution to the improvement of Chinese economic through the healthy development of enterprises. (3) Human capital, income distribution and industrial structure have a regulating effect on the relationship between corporate social responsibility and the quality of economic growth. The higher percentage of higher education population, the smaller urban-rural income gap and the higher proportion of third industry in second industry are conducive to the formation of positive incentives between the corporate social responsibility and the quality of economic growth. Therefore, expanding the accumulation of human capital, narrowing the income distribution gap and adjusting the industrial structure are still important channels of achieving high quality of economic growth in the new era.

## References

1. Chao, X. J., Ren, B.P., Xu, L.: Regional Disparity of the Quality of China's Economic Growth: Based on the Test of the Semi-Parametric Model for Heterogeneity over Time and across Individuals (in Chinese). *Journal of Jiangxi university of finance & economics* 1, 10-20 (2016). DOI: 10.13676/j.cnki.cn36-1224/f.2016.01.002.
2. Chao, X. J., Ren, B.P.: The Fluctuation and Regional Difference of Quality of Economic Growth in China (in Chinese). *Economic research* 46(4), 26-40 (2011).
3. Chao, X. J., Hui K.: Measuring Quality of Economic Growth of China (in Chinese). *The journal of quantitative and technical economics* 6, 75-86 (2009). DOI: 10.13653/j.cnki.jqte.2009.06.008.
4. Huang, J. B., Xu, J., Xu, S.: Land Price Distortion Enterprises' Property and Over - investment: An Empirical Research Based on the Data of Chinese Industrial Enterprises and Land Price of Cities in China (in Chinese). *China industry economic* 3, 57-69 (2015). DOI: 10.19581/j.cnki.ciejjournal.2015.03.005.
5. Ren, B. P., Gan, H.X.: Construction the Micro Mechanism of Improving Chinese Quality of Economic Growth (in Chinese). *Guizhou social science* 5, 111-118 (2016). DOI: 10.13713/j.cnki.cssci.2016.05.019.
6. Wang, S. H.: A Study of the Influence of Management Background Characteristics on Corporate Social Responsibility: Empirical Evidence from Chinese A-share Listed Companies (in Chinese). *Accounting research* 11, 53-60+96 (2016).
7. Xiao, H. J., Li, W.Y., Hu, Y.L.: True or False Proposition: A New Thinking about the Testing of CSR (in Chinese). *China industry economic* 2, 102-114 (2015). DOI: 10.19581/j.cnki.ciejjournal.2015.02.010.
8. Xu, S., Huang, J.B.: Media Governance and Corporate Social Responsibility (in Chinese). *Chinese journal of management* 7, 1072-1081 (2015).
9. Xu, Z. L., Liu, N.: Research on Management Integration of CSR and Corporate Strategic Objective Based on Sustainable Development (in Chinese). *China industry economic* 9, 129-140 (2008). DOI: 10.19581/j.cnki.ciejjournal.2008.09.013.



## Macroeconomic Aspects of Low Emission Limitations in the Lubuskie Voivodship

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**Abstract.** The publication pointed to macroeconomic determinants of low emission reduction in the Lubuskie Voivodship. It was also emphasized that in the area of Lubuskie Voivodship, the problem of low emission is very serious even though the Lubuskie Voivodship does not belong to strongly urbanized and densely populated areas. Moreover, the most significant problems related to low emission in the Lubuskie Voivodship were indicated as well as the main sources of low emission and their impact on the most important macroeconomic parameters in this area were identified. The article also notes that previous actions that were to contribute to the reduction of low emission did not bring the desired effect. Low emission is not a characteristic feature of the Lubuskie Voivodship, this problem applies to all of Poland, where every year, according to the European Environment Agency, almost 50.000 people die prematurely due to excessive air pollution. At the end, the conclusions were presented.

**Keywords:** Low Emission, Middle Odra Region, Macroeconomy.

### 1 Introduction

The air quality in the Lubuskie Voivodship and in Poland as a whole is significantly different from the standards in most EU countries. This is despite the fact that the area of the Lubuskie Voivodship is not strongly urbanized and the average number of people living in 1 km<sup>2</sup> is smaller than the rest of Poland. The problem of low emission in the Lubuskie Voivodship is so complex that it should also be considered in macroeconomic terms. It should be emphasized that due to the complexity of the problem, it may be impossible to solve it in a short time. It is assumed that low emission is generated at an altitude not exceeding 40 meters from the ground level. The main low emission sources are home-heating boilers, road transport and small industrial plants [14, 15]. The purpose of the article was to indicate macroeconomic determinants of low emission reduction in the Middle Odra Region. No statistical data necessary for the preparation of this article are collected for the Middle Odra Region, therefore the authors of the publication were forced to use data on the level of emissions in the Lubuskie voivodship. The area of the Lubuskie voivodship largely coincides with the area of Middle Odra Region [16].

## 2 The Problem of Low Emissions in the Lubuskie Voivodship

People already knew about the harmfulness of dust to human health in the 16th century. This is evidenced by the work *De re metallica* by Georgius Agricola, but it should be remembered that at that time mainly attention was paid to pollinated mines. Work in difficult conditions led to a number of diseases of the respiratory system [2]. Contaminated air therefore has a negative impact not only on the environment, but also on human health, because the toxins in the air pollute the soil, plants, water and food. The problem of atmospheric pollution, which is caused by low emission, does not affect only large cities where dense buildings predominate. Low emission is also a problem in rural areas and places of larger clusters of residential buildings, including single-family houses [12, 14]. Particularly the problem of pollution originating from domestic boiler rooms concerns older detached buildings, which are often non-insulated and equipped with an old, ineffective heating installation [17]. In addition to the ineffective heating installation, the quality of the fuel used is a very serious problem. In low-carbon coal-fired boilers, low-quality coal is often used, from which many substances harmful to human health and environment are released during combustion [29, 30].

A distinction must be made between low emission from gaseous and particulate pollutants arising in medium and large industrial plants and in power plants [14]. In recent years, the issue of gases and dust emissions to air from industry has been significantly reduced (Tab. 1 and 2).

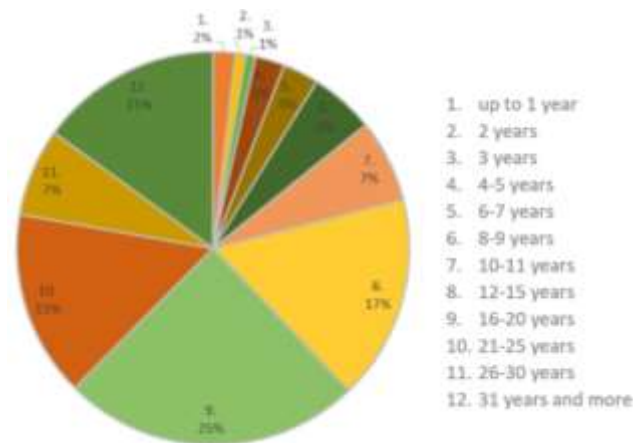
**Table 1.** Emission of dust pollution by enterprises particularly troublesome in 2007-2016 [21].

Area		Lubuskie voivodship	Poland	Share (%)
Gas emissions (thousands of (Mg/year)	2007	1.6	94.8	1.7
	2008	1.4	76.8	1.8
	2009	1.4	61.7	2.3
	2010	1.4	62.5	2.2
	2011	1.3	57.5	2.3
	2012	1.2	52.4	2.3
	2013	1.1	49.5	2.2
	2014	1.0	47.4	2.1
	2015	0.9	44.3	2.0
	2016	0.9	38.6	2.3

**Table 2.** Emission of gas pollutants by enterprises particularly troublesome in 2007-2016 [21].

Area		Lubuskie voivodship	Poland	Share (%)
Gas emissions (thousands of (Mg/year)	2007	2 019.1	223 269.5	0.9
	2008	1 842.3	216 319.0	0.9
	2009	1 952.4	203 125.6	1.0
	2010	2 080.9	216 155.4	1.0
	2011	2 089.6	220 928.0	1.0
	2012	2 054.2	216 513.7	1.0
	2013	2 009.5	217 492.0	0.9
	2014	2 009.1	209 067.3	1.0
	2015	2 000.1	211 566.3	0.9
	2016	2184.2	210 849.4	1.0

It should be emphasized that the main source of pollutant emissions to the air in the Lubuskie Voivodship is low emission, which results from human activity. Natural emission, which results from processes occurring in nature, although it cannot be completely omitted during the analysis of this issue, is of marginal significance because it has a small influence on the air quality in the Lubuskie Voivodship. Low emission is a problem of densely populated areas. At the same time, the low emission, which usually comes from sources such as home-heating boilers, road transport and small enterprises, has a major impact on air quality, especially in cities [13, 26]. The size of this issue is difficult to estimate: it ranges from a few to a dozen or so percent of total emissions in areas with a developed heating network and up to several dozen percent - in areas where central heating systems do not cover. The largest share of low emission in total of pollutants that enter the air occurs in rural areas. Particularly high concentrations of pollutants, which are the source of low emission, are recorded during the heating season [14]. In areas of high traffic routes and densely populated areas, a significant issue is the low emission, the source of which is car communication [22]. When combusting fuels in automotive engines, many harmful substances enter the air. A serious problem in the Lubuskie voivodship is the age of cars. A large part of them are old cars, which are equipped with non-ecological engines. The data presented in Fig. 1 shows that as many as 86% of cars registered in the Lubuskie voivodship in 2016 are of 10 or more years old. It should be assumed that with the improvement of macroeconomic indicators, the age structure of cars in the Lubuskie voivodship will begin to change. Together with the increase in affluence of the inhabitants of the Lubuskie Voivodship, it is expected that the share of the oldest cars will decrease. As is the case, for example, in Germany. Moreover, passing cars contribute to the so-called secondary emission, consisting in picking up dust from roads by passing cars [26].



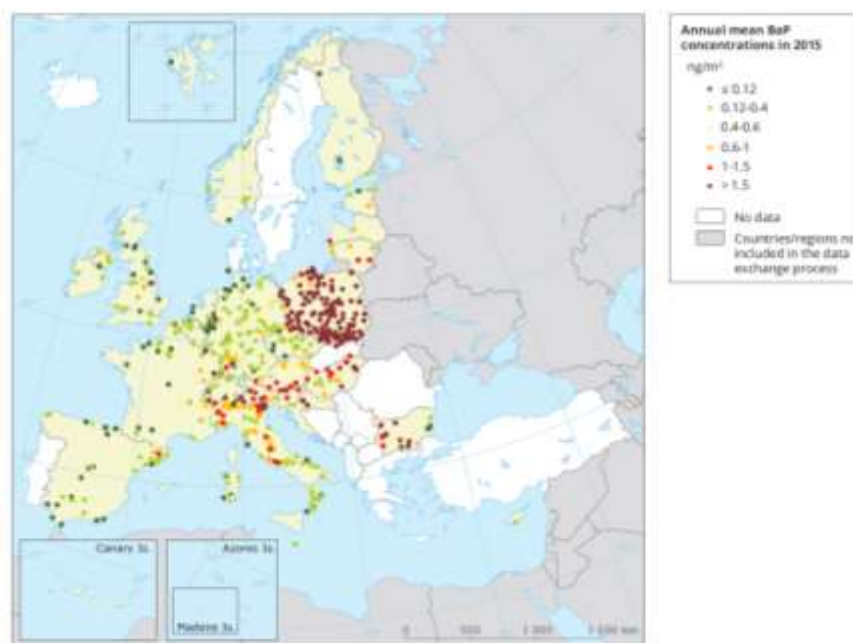
**Fig. 1.** Breakdown of passenger cars into groups due to their age in 2016 in the Lubuskie voivodship [21].

### 3 The Impact of Low Emission on the Lubuskie Voivodship Economy in Macroeconomic Terms

Low emission has a negative impact on many areas of people's lives. Also in macroeconomic terms, it is a significant problem for the economy of the country and the region. The negative impact of low emission is often indirect, but it cannot be neglected when analysing the impact of air pollutants on macroeconomic factors [4, 24, 28]. It should be emphasized that one of the most harmful substances for human health is benzo(a)pyrene - B(a)P [31]. This substance in elevated concentrations occurs not only in the Lubuskie Voivodship, but also throughout Poland (Fig. 2). Low emission may have a negative impact on macroeconomic factors such as: quality of workforce, economic situation (region, country), level and structure of prices, economic growth rate, tax tariffs and fiscal policy [14].

One of the most important macroeconomic factors that is dependent on low emission is the quality of the workforce. People staying in places where low emission is particularly annoying will be more likely to get ill. It is not just about life-threatening diseases, such as heart or lung diseases, but also the quality of life, which is reduced by a higher risk of less severe factors affecting people's health. These include, among others, allergies that may occur more often in areas characterized by low air quality. Low emission can cause more days of absence from employees in the workplace due to illness. In turn, activities aimed at reducing low emission may contribute to reducing unemployment. The necessity to carry out tasks aimed at reducing the occurrence of harmful substances in the air may entail the creation of new jobs [16]. Such a situation may take place in mines where coal is mined, especially the lower quality, which contributes to the creation of low emission [31]. The low level of unemployment currently taking place in Poland seems to be a good moment to undertake activities

aimed at limiting the extraction of coal with the lowest heating parameters [17,25], which also contains a large amount of pollutants that are released during combustion.



**Fig. 2.** Concentrations of B(a)P, 2015 [3].

It should be emphasized that individual substances that are part of low emission adversely affect human health [14]. Particularly noteworthy is the PM<sub>2.5</sub> dust, which according to the reports of the World Health Organization has the ability to penetrate into the alveoli. It should be underlined that even short-term exposure to the increased concentration of PM<sub>2.5</sub> dusts threatens the health and life of people due to respiratory system diseases, blood circulation and the number of medical cases that require hospitalization [11]. On the other hand, long-term arrival in a place where the concentration of PM<sub>2.5</sub> is too high contributes to a shorter life span. It is estimated that the life of the average EU citizen is shorter due to this reason by more than 8 months [20, 23]. In Poland, however, it is estimated that people's lives are shorter by about 10 months. Poor air quality directly affects the poor health condition of the whole society, which in turn translates into increased budget expenditure for the treatment of diseases and costs associated with reduced productivity [6]. It is estimated that in the Małopolskie voivodship these expenses amount to approximately PLN 2.8 billion annually [18]. As a result of inhaling by people of air contaminated with an excessive amount of PM<sub>2.5</sub>, nearly 500.000 premature deaths are registered in Europe every year [21]. Poor air quality is the most important cause of premature death in the EU, which is associated with a polluted environment. It should be emphasized that polluted air contributes to ten times more deaths than road accidents. Only in 2010, poor air quality contributed to over 400.000 premature deaths. In addition, there have been numerous

cases of diseases that could have been avoided [17]. It is estimated that the overall external costs of the effects of poor air quality in Europe in 2010 ranged from EUR 330 to 940 billion [9].

The economic situation is an important macroeconomic factor that may depend on the low emission level. This can be particularly noticeable in local conditions. For example, entrepreneurs investing in the tourist sector may not take the risk of locating investments in a place where low emission is particularly burdensome. An important macroeconomic factor that may indirectly be dependent on low emission is inflation. Striving to maintain a low inflation level while maintaining a relatively high rate of economic growth is often difficult to achieve. These activities can be all the more difficult when the state budget is charged with a high financial penalty for too high a low emission level. The necessity to cover a possible financial penalty may entail the desire to launch more money on the market, which in turn will contribute to inflation which has a negative impact on the undertaking of structural actions [7]. Low emission may also affect the rate of economic growth. The Polish authorities may be forced to significantly increase expenditure on reducing low emission, which will entail the need to reduce the level of investment in other branches of the economy [27]. Such a situation may reduce the rate of economic growth. Estimates have been already known to limit the competitiveness of the European Union economy due to a number of environmental restrictions that are often not found in other countries outside the EU. This situation means that other economies that are not burdened by environmental restrictions are able to produce products at lower prices than in the EU [17]. This has a significant impact on the competitiveness of production.

This has a significant impact on the competitiveness of production [8]. Tax rates may be subject to changes due to low emission [1,5]. Higher taxation of non-ecological cars may be one of the elements of low emission impact on the state's fiscal policy. Fiscal policy should be understood as the selection of means for collecting public revenues, as well as the directions and ways of spending public funds to achieve economic and social goals, which have been set by public authorities [19]. State authorities may be forced to take unpopular decisions that will lead to higher tax burdens on citizens due to too much harmful substances in the air. The need to introduce may result not only from excessive concentrations of pollutants in the air, but also from commitments undertaken by individual countries as part of their functioning in the European Union. Moreover, there are a number of other actions by public authorities with regard to budget inflows and expenses, the aim of which is to strengthen controls and influence the distribution of income, as well as the level of economic activity of individual entities in the country. A large part of the impacts directly or indirectly affects the economic conditions of the functioning of households and enterprises and their decisions. Monetary policy has a significant impact on the market and preferential rate of credit allocated for pro-ecological activities aimed at reducing low emission [17]. As examples of other countries show through fiscal policy, it is possible to effectively influence the reduction of dust and gas pollutants that get into the air. At the same time, it is not only important to set higher tax rates for non-ecological heating installations or cars, but it is also significant to introduce various types of tax incentives and subsidies for ecological solutions. An example of a country that effectively

encourages its citizens to buy environmentally friendly cars is Norway, which has introduced privileges for all electric cars.

It should be noted that the level of emissions to air in Poland in 2015-2016, with few exceptions, was not limited (Tab. 3). When analysing harmful substances that are emitted into the air, it should be stated that the majority of them were characterized by a higher emission level in 2016 than in 2015.

**Table 3.** Emission volumes in the years 2015 – 2016 for the particular pollutants [9].

Pollutant	2015	2016	2016/2015
	Mg		(%)
SO <sub>2</sub>	701 831.5	581 520.3	82.86
NO <sub>x</sub>	704 824.3	726 431.2	103.07
NH <sub>3</sub>	267 312.2	267 107.2	99.92
CO	2 370 432.8	2 505 631.3	105.70
NMVOC	590 627.8	608 858.3	103.09
TSP	342 017.6	352 306.1	103.01
PM10	248 654.5	259 165.3	104.23
PM2.5	138 343.5	145 506.9	105.18
BC	19 794.0	21 260.7	107.41
Pb	420.9	418.3	99.38
Cd	12.3	13.1	106.63
Hg	10.6	10.3	97.85
As	30.7	28.3	92.14
Cr	32.7	33.9	103.79
Cu	329.6	316.5	96.04
Ni	81.6	82.4	100.89
Zn	863.2	836.8	96.93
	kg		
PCB	627.3	634.3	101.11
HCB	4.8	4.9	101.89
PAH	139 467.9	146 344.4	104.93
	g I-TEQ		
PCDD/F	290.0	282.3	97.37

The harmful substances that significantly contribute to the low emission are:

- suspended dusts (PM10 and PM 2.5),
- nitrogen oxides (NO<sub>x</sub>),
- sulphur dioxide (SO<sub>2</sub>),
- carbon monoxide (CO),
- non-methane volatile organic compounds (NMVOC).

From the data presented in Tab. 3. it appears that almost all harmful substances that are emitted into the air, which low emission is an important source, increased in 2016 compared to 2015. The exception is only sulphur dioxide, whose level of emissions in

2016 compared to 2015 was significantly lower. In 2016, SO<sub>2</sub> emissions were lower by approx. 17% compared to 2015. The drop in emissions in Poland was mainly due to the reduction of emissions from professional and industrial power, which resulted from operators adapting from January 1, 2016 to the requirements resulting from implementation of Directive 2010/75/EU on industrial emissions in the scope of stricter emission standards for SO<sub>2</sub> [10].

## Conclusion

In the Lubuskie Voivodship there are elevated concentrations of harmful substances in the air, the main source of which is low emission. High concentrations in the air B(a)P are particularly unfavourable, which often exceed the acceptable limits. B(a)P is not only one of the most dangerous for human health substance that gets into the air. B(a)P also affects the macroeconomic parameters of the region. So far, effective solutions have not been implemented that would lead to the reduction of low emission in the Middle Odra Region.

It should be emphasized that despite the development of air protection programs for all zones in the Lubuskie Voivodship due to exceeding the normative values: particulate matter PM<sub>10</sub>, B(a)P and arsenic. Moreover, the national program (Clean Air) is currently being launched to reduce low emission. The program provides for grants and loans that are to contribute to the right energy efficiency and reduce the emission of dust and other pollutants into the air from existing single-family residential buildings or to avoid emission of air pollutants from newly built single-family residential buildings. However, the effectiveness of the currently implemented solutions can only be assessed in the coming years.

**Acknowledgements.** This study was conducted and financed in the framework of the research project “Economic, ecological and social aspects of low emission limitations in the Middle Odra”, granted by the National Science Centre in Poland, program SONATA, grant No. 2015/19/D/HS4/00210.

## References

1. Adamczyk, J., Piwowski, A., Dziuk, M.: Air protection programmes in Poland in the context of the low emission. *Environmental Science and Pollution Research*, 24(19), 16316–16327 (2017).
2. Agricola, G.: *De re metallica*, Basel, (1556).
3. Air quality in Europe - 2017 report, European Environment Agency, Luxembourg: Publications Office of the European Union (2017).
4. Ali, G., Anbren, S., Bashir M.K.: Climate mitigation, low-carbon society, and dynamism of educational institutes in a low-income country. *Environmental Science and Pollution Research*, 25(4), 3775-3784 (2018).
5. Awasthi, A., Hothi, N., Kaur, P., Singh, N., Chakraborty, M., Bansal, S.: Elucidative analysis and sequencing of two respiratory health monitoring methods to study the impact



- of varying atmospheric composition on human health. *Atmospheric Environment*, 171, 32-37 (2017).
6. Barro, R. J.: Inflation and Economic Growth. *Bank of England Quarterly Bulletin*, pp. 39-52 (1995).
  7. Burchart-Korol, D., Pustejovska, P., Blaut, A., Jursova, S., Korol, J.: Comparative life cycle assessment of current and future electricity generation systems in the Czech Republic and Poland. *International Journal of Life Cycle Assessment* (2018) <https://doi.org/10.1007/s11367-018-1450-z>.
  8. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Clean Air Programme for Europe, European Commission, Brussels (2013).
  9. Dębski, B., Olecka, A., Bebkiewicz, Chłopek, Z., Kargulewicz, I., Rutkowski, J., Waśniewska, S., Zasina, D., Zimakowska-Laskowska, M., Żaczek, M.: Krajowy bilans emisji SO<sub>2</sub>, NO<sub>x</sub>, CO, NH<sub>3</sub>, NMLZO, pyłów, metali ciężkich i TZO za lata 2015 - 2016 w układzie klasyfikacji SNAP. Raport syntetyczny. Krajowy Ośrodek Bilansowania i Zarządzania Emisjami (KOBiZE). Instytut Ochrony Środowiska – Państwowy Instytut Badawczy, Warszawa (2018).
  10. Dockery, D.W.: Epidemiologic evidence of cardiovascular effects of particulate air pollution. *Environmental Health Perspectives*, 109, 483-486 (2001).
  11. Dvorský, J., Petráková, Z., Holý, J.: Comparison of Housing Construction Development in Selected Regions of Central Europe IOP Conference Series: Earth and Environmental Science 95(4),042052 (2017).
  12. Dzikuć, M., Adamczyk, J., Piwowar, A.: Problems associated with the emissions limitations from road transport in the Lubuskie Province (Poland), *Atmospheric Environment*, (160) 1-8 (2017).
  13. Dzikuć, M., Adamczyk, J.: The ecological and economic aspects of a low emission limitation: a case study for Poland. *International Journal of Life Cycle Assessment*, 20(2), 217-225 (2015).
  14. Dzikuć, M., Dzikuć, M.: The prospects for limiting emissions from road transport: A case study for the Middle Odra and Poland. IOP Conference Series: Earth and Environmental Science, 121(3),032006 (2018).
  15. Dzikuć, M., Kułyk, P., Dzikuć, M., Urban, S., Piwowar, A.: Outline of Ecological and Economic Problems Associated with the Low Emission Reductions in the Lubuskie Voivodeship (Poland). *Polish Journal of Environmental Studies*, 28(1), 1-8 (2019).
  16. Dzikuć, M.: Ekonomiczne i społeczne czynniki ograniczenia niskiej emisji w Polsce. Difin, Warszawa (2017).
  17. Efektywność energetyczna w Polsce, Przegląd 2013, Domy jednorodzinne, efektywność energetyczna a jakość powietrza. Instytut Ekonomii Środowiska, Kraków, pp. 41-42 (2014).
  18. Fedorowicz, Z.: Polityka fiskalna. Wydawnictwo Wyższej Szkoły Bankowej w Poznaniu, Poznań (1998).
  19. Katsouyanni, K., Touloumi, G., Samoli, E., Gryparis, A., Le Tertre, A., Monopoli, Y., Rossi, G., Zmirou, D., Ballester, F., Boumghar, A., Anderson, H.R., Wojtyniak, B., Paldy, A., Braunstein, R., Pekkanen, J., Schindler, C., Schwartz, J.: Confounding and effect modification in the short-term effects of ambient particles on total mortality: results from 29 European cities within the APHEA2 project. *Epidemiology*, 12(5), 521-531 (2001).
  20. Krajowy Program Ochrony Powietrza do roku 2020. Ministerstwo Środowiska, Warszawa, pp. 38-39 (2015).

21. Krauze-Biernaczyk, M., Czarniecka, P., Kociołek E.: Roczna ocena jakości powietrza w województwie lubuskim, Wojewódzki Inspektorat Ochrony Środowiska w Zielonej Górze, Zielona Góra, pp. 17-19 (2018).
22. Llano-Paz, F., Calvo-Silvosa, A., Antelo, S.I., Soares, I.: Power generation and pollutant emissions in the European Union: A mean-variance model. *Journal of Cleaner Production*, 181(20), 123-135 (2018).
23. Lubecki, L., Oen, A.M.P., Breedvel, G.D., Zamojska, A.: Vertical profiles of sedimentary polycyclic aromatic hydrocarbons and black carbon in the Gulf of Gdańsk (Poland) and Oslofjord/Drammensfjord (Norway), and their relation to regional energy transitions. *Science of The Total Environment*, 646(1),336-346 (2019).
24. Piwowar, A., Dziuk, M.: Outline of the economic and technical problems associated with the co-combustion of biomass in Poland. *Renewable and Sustainable Energy Reviews*, 54, 415-420 (2016).
25. Shane, A., Kafwembe, Y., Kafwembe P.: The viability of biomethane as a future transport fuel for Zambian towns: A case study of Lusaka. *Journal of Energy in Southern Africa*, 29(3), 86-95 (2018).
26. Usubharatana, P., Phungrassami, H.: Life Cycle Assessment for Enhanced Efficiency of Small Power Plants by Reducing Air Input Temperature, *Polish Journal of Environmental Studies*, 27(4) 1781-1793 (2018).
27. Vega-Coloma, M., Zaror, C.A.: Environmental impact profile of electricity generation in Chile: A baseline study over two decades. *Renewable and Sustainable Energy Reviews*, 94, 154-167 (2018).
28. Weldu Y.W., Assefa G., Joliet O.: Life cycle human health and ecotoxicological impacts assessment of electricity production from wood biomass compared to coal fuel. *Applied Energy*, 187, 564–574 (2017).
29. Weldu, Y.W.: Life cycle human health and ecosystem quality implication of biomass-based strategies to climate change mitigation. *Renewable Energy*, 108, 11-18 (2017).
30. Woźniak, J., Pactwa, K.: Responsible Mining-The Impact of the Mining Industry in Poland on the Quality of Atmospheric Air. *Sustainability*, Vol. 10, no. 4, 1184-1200 (2018).
31. Yang, T., Liu W.: Does air pollution affect public health and health inequality? Empirical evidence from China. *Journal of Cleaner Production*, 203(1), 43-52 (2018).

## Carbon – to Trade or Tax – that’s the Question!

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**Abstract.** The choice of between carbon emission trading and taxing carbon is framed as a pragmatic one, as essentially just different ways of implementing the same policy. We argue that this is not the case. The choice of policy instrument is strongly dependent on the will to make the system work. If there was a real will to reduce emissions, a carbon tax would have been and will be the preferred instrument, if there is no will – an emission trading is the best excuse available for not creating a high, not to speak about an ever-increasing carbon price. The “will” is result of the national and international relationship of forces between national and international interest groups. These relationship of forces is dependent on the possible social and political conflicts arising from the income distribution effects of an efficient carbon price, both on a national, supra-national, and international level. The key to formulating efficient climate policies is to focus on the income distribution effects on all these levels. The importance of income effects of carbon pricing has been illustrated by the massive popular mobilization against the petrol tax in France in November and December 2018. The choice between emission trading and carbon taxation is in fact an expression of the will to price carbon in a way that has a significant effect on emissions. Twelve years later, with the failure of the EU ETS, “riots” of the yellow vests, and the recent failure of the COP24 in Katowice, this insight must be the starting point of climate policy from now on.

**Keywords:** Border Tax Adjustments, Carbon Pricing, Emission Trading.

### 1 Introduction

The aim of this paper is to reflect on the experiences of carbon pricing policies a key element of any policy aiming at avoiding catastrophic climate change. Given the enormous amount of academic literature and even more so the often even more relevant reports and analysis from various climate policy think tanks this is in a direct sense an impossible task. Our contribution will not be in any encyclopedia overview over the literature, but to point out some, in our opinion, important factors, which is typically lacking in a great deal of the literature, which is the effects on income distribution of the various policies and the effect that has for the possibility to

mobilize sufficiently political support – or the other way around – avoid to strong social resistance to the policies one wishes to implement if one happens to be in power. From this follows that although there is a rare and surprisingly broad consensus among various schools of economic thought, from Marxists to Marginalist so to speak, that a carbon tax is generally preferable to an emission trading system, carbon tax systems is clearly marginal relative to emission trading systems when it comes to the amount of global emissions priced by carbon taxes. Why aren't economists listened to?

But before starting out to answer that question when it comes to national or EU policy, it is necessary to ask why there has been no success in reaching a legally binding international agreement, which in our opinion again is based on not making the income effects of such an agreement explicit. Why is it that after decades of COPs, that all we have is a system of NDCs, nationally determined contributions, which summed up clearly does not put us on path towards limiting global warming to 2 degrees, not to speak of limiting the warming to 1.5 degrees.

## **2 Methodology and Structure of the Article**

The descriptive analysis has been used as a main scientific method in this article, where authors have analyzed several available resources about climate changes, as well as results from COP24 Conference in Katowice, where these results have not been published yet.

The paper is structured in the following way. Part 2 discusses the politics that is the possibility of reaching an international agreement. The conclusion is that any realistic analysis of the deeply conflicting interests should have led to the conclusion that such an agreement could not be reached by a consensus-based agreement and that should have been realized by anyone really interested not only emission reductions, but less ambitious – not rising emissions. The contribution by Nordhaus on “climate clubs” as a way to build to get an international price on CO<sub>2</sub> is discussed as an important contribution to strategies starting from the national/continental level a resulting in a de facto agreement on carbon pricing internationally.

Part 3 analyses the development of the EU emission trading system (hereafter EU ETS) as the result not of a rational logic of how to reduce emissions in the most cost-efficient way, but from a political logic how to at the same time do something about the emissions without “rocking the boat”, that is changing the socio-political status quo in any significant way. In our opinion this became very evident in the reform period from 2014 to 2018 where a lot of proposals for making the EU ETS work was put forward, but predictably not implemented, since the “spirit” of the EU ETS is to avoid policies that will give a steady increase in the price of emissions, that is policies that would bring emissions significantly down – even if still far less than needed from a climate science point of view.

Part 4 sums up the lessons we think should be learned, in particular sketching a new research agenda when it comes to the economics of climate policy.

### **3 The Impossibility of an International “Burden Sharing” Agreement**

#### **3.1 Differentiated Responsibilities or Capacities?**

A key issue, and a key principle in the COP process has been “Common but differentiated responsibilities”, the CBDR principle. This is not a new principle. It was also used in the Montreal Protocol, dealing with the depletion of the ozone-layer (CISDL 2002). Both problems are important and urgent, but since they are of totally different order of magnitude the CBDR takes on a totally different importance, again by order of magnitude. Practically nothing changed in most people lives and incomes from the “ban” of using HCFCs. Even the fridges look – and cost the same.

In contrast, a ban, or even a phasing out of fossil fuels would change, if not “everything” (Naomi Klein) so at least technologies, prices, trade patterns, profits and incomes. In fact, the continued use of fossil fuels was seen as so essential to developing countries so in the Kyoto protocol most countries had no obligation to reduce emissions at all. Not even a symbolic one. They were allowed to increase their emissions.

In reality it was never – and could not be a question of responsibility, but of capabilities. This because to calculate the responsibility involves a making several ethical judgements around which it is impossible to form a consensus. Were the US, UK and the USSR entities that could take on any sort of historical responsibility over a timespan of in principle 200, but at least 100 years? First of all, besides an extremely small group of natural scientists, nobody, neither the ruling class, nor the oppressed classes, did not know that GHG emissions were a problem at all. In practice global warming became a problem in the sense that that the political elites and ordinary people could act in a conscious way to the problem from late 1980ies. Should ordinary people in the Soviet Union reduce their consumption, their level of welfare in order to take responsibility for the emissions that happened under Stalin and his heirs? Has a level of democracy been established in Russia even after 1990 that makes ordinary people responsible even for the emissions that happened after the fall of the bureaucratic dictatorship? What level of collective and individual effort and willingness to sacrifice would make one say that the Russian people took their share of responsibility for global warming. In a similar vein one could ask if the American people are responsible for the US now withdrawing from the Paris agreement? The majority voted for Clinton, but an archaic and undemocratic electoral system made the republican, climate denialist Trump president despite the clear majority for the Clinton. What about the minorities in the US, the native Americans, the blacks, the Hispanics, are they equally responsible as the WASP majority? The peak of civil liberties movement is just over 50 years ago – and still there are campaigns like “Black lives matter”. In short to be held responsible for contributing to climate change one needs to a clear influence on political outcomes and as we will discuss when it comes to the formulation of national climate policy many groups in society

are clearly not in a position to get implemented climate policy in aligned with their short term and/or long-term interests.

In reality it was never a question of responsibilities, but of capabilities. The Ozone layer, global warming is clearly a common responsibility, so the principle is much closer to the formula to each according to his/her needs, from each according to his/her capabilities. So what we all get when we solve the climate is a less unstable climate, less catastrophes, like breakdown in important eco-systems supporting food production, less extreme weather causing draughts, wild-fires, flooding etc. Our capabilities are also very different. Parties and persons in important power positions have more possibility to influence politics. In society a professor in social sciences has generally more power than the person cleaning the university offices, due to large differences in all types of “capital”. Consequently the more capabilities you have to solve our common problems the more responsibility you have, but has nothing to do with any historic, that is through generations, , accumulated responsibilities.

### **3.2 “Common, but Minimal Action”**

Already in Rio in 1992, the alternative principle for a “burden sharing” agreement was what we want to call “common, but minimal action”. As the COP has demonstrated very clearly - is that it was as is impossible to agree on burden sharing according to responsibilities, besides what each country voluntarily wanted to do, which of course by the nature of the game is much less than what is needed. If one had agreed in the early nineties that everybody had to do something, for example a carbon tax starting with of 1 USD, rising with one dollar each year, that would have had a much stronger effect on the emissions, on technological development. In addition, we would have wasted much less time and resources on negotiations leading to almost nothing, that is a list of voluntary “contributions”, which by no stretch of fantasy will amount to avoid a cataclysmic climate changes.

### **3.3 Who are “we”?**

Our main hypothesis is that the “we”, the countries participating to the COP-process did not want to do what was needed to save the climate. Countries are not a homogenous entity with one “will”. There is no “representative agent”. Countries consist of different interest groups. Since space does not allow any realistic analysis of these groups and their climate policy, as economists often do “assume” a very simple model where each country consists of a set of ruling elites that decides policy and “ordinary people” that does not influence the climate policy of the country. Ordinary people can roughly be defined as people that are not in the top two deciles of the income distribution, most of them, wage earners, students, and people on various benefits. The top two deciles have a significantly disproportionate share of both financial, real and social capital. The key question then becomes: are the rulers more interested in defending their disproportionate share of social wealth than they are in saving the climate. If the upper 2-3 deciles of the income distribution do not want an efficient climate policy, that is a policy that rapidly reduces the emissions,

there will be no reduction of emissions, since they, with all their resources are able to block any efficient policy. Our key point is that any politically possible and consequently the only efficient climate policy will be a threat to the vested interests of the ruling elites.

### **3.4 From Rio to Kyoto**

The UN Conference on the Environment and Development was held in Rio de Janeiro in 1992. Its main outcome was the establishment of the United Nations Framework Convention on Climate Change (UNFCCC) and the start of a series of top-level climate policy conferences known as the Conference of the Parties (to the Convention), the COP. The first COP meeting, COP1, is held in Berlin in 1995, but it is the 3rd COP meeting in Kyoto which is the first milestone in international climate policy. The Kyoto protocol is the first evidence of the fact that the rulers both in rich and poor countries, did not want to do anything about climate change. Most countries did not have any reduction targets at all, and the Annex B countries, practically speaking EU, Canada and Australia did prepare the loopholes from the start. Canada withdrew from Kyoto and Australia also in practice sabotaging it, by making the year 2000, the baseline year and demanding that the scandalous Clean Development Mechanism to be continued [8].

### **3.5 The EU from Rio To Kyoto**

The initial reaction of the EU after the Rio meeting was to prepare for the introduction of a carbon tax. The various schools of economics, from Marxists to neo-classical Marginalists agree on that a carbon tax on fossil fuel charged at the “source” is the less bureaucratic, cannot be an object of speculation as pointed out in the [10] and treated at length in [6]. The following key points taken from [10] make this clear:

- Carbon taxes are generally easier to administer than a cap-and-trade system because they neither involve a market-based trading system nor require enforcing rules to prevent market manipulation.
- Moreover, they (carbon taxes) can be built on existing taxes (such as a fuel excise tax) and economic actors can predict their estimated liabilities reasonably well.
- Similarly entrepreneurs who invest in low-GHG technologies can anticipate the market advantage of their products relative to their dirtier competitors,
- (but) a carbon tax does not guarantee hitting a particular emissions target in any given year
- (but) what matters are the cumulative emissions – the year-to-year emissions are not of great concern in themselves.

The often mentioned point that emission trading with a cap controls the amount of emissions is first of all of little interest since we must not only go down to zero emissions – which means no use of fossil fuel, we must have “negative” emissions.

Negative emissions mean capturing and storing CO<sub>2</sub> in forests, in old oilfields and so on.

In light of the clear-cut, real-world advantage of a carbon tax to get emissions down, [7] correctly points out that “The EU has developed the first and largest international emissions trading system in the world. This development is puzzling due to the EU’s scepticism to international emissions trading in greenhouse gases (GHGs) in the run-up to the 1997 Kyoto Protocol”. Not only in the run-up: “Most EU member states were, as noted, sceptical or even hostile to emissions trading during the 1997 Kyoto negotiations”. The same point is made by [2]. He sees the EU ETS as the “... product of two failures; first, the European Commission failed in its initiative to introduce an effective EU-wide carbon energy tax in the nineties. Secondly, the Commission fought unsuccessfully against the inclusion of trading as a flexible instrument in the Kyoto Protocol in 1997”. To analyse in detail why the EU commission failed is not the aim of this article, grosso modo it is no mystery. The proposal for a carbon tax met with strong opposition from dominant parts of industry in EU and from the US government, reflecting a rejection of the idea of a carbon tax from major parts of US industry, but a detailed analysis of the change position we have no found. The above-mentioned authors, and sources they point to like [3], mostly just mentions it as a starting point for discussing how the EU ETS became the key climate policy in the EU. In any case - a strong and early indication that the US would not participate was that in July 1997 the US senate voted 95-0 against any treaty that would have any mandatory obligations for developing countries. While there certainly was a good deal of out-right denial of the problem behind that vote against what was to become the Kyoto-protocol it pointed to a the clear weakness of the principle of “common, but differentiated responsibilities” as implemented in the Kyoto protocol, that the “innocent”, developing countries were allowed to use fossil fuels as if the problem was not urgent and to that it was not important that every country had do something – how-ever “little” from the start because that would make the process – also for them more gradual, less dramatic. Not the least because if everybody did something, a very clear signal would have been sent to the fossil fuel industry that its days were numbered.

### **3.6 Preparing and Implementing the Loopholes**

After the twin failures, the carbon tax and avoiding flexible mechanisms, the aim could only be to implement a “make-believe” system that is a system that looked like you were doing something, when you were not. . Because as we will argue below it was the deep “fear” in the ruling elites of a high carbon price that would meet with from not only owners of firms being afraid of losing competitiveness, but mainly from ordinary people that would see a flat – and most importantly – ever-rising carbon tax as socially unjust. If that hypothesis is correct or not, we cannot discuss at length, but the fact is that the EU ETS from the start had built in a lot of safety valves against the possibility of the carbon price. First of all, the EU ETS did not and do cover the whole economy, only 40 percent. In our view it is not any mystery why transport is not included in the EU ETS. An increasing price of petrol is probably the



most important single price that ordinary people care about. That any attempt at significantly rising the price of petrol would meet considerably popular opposition was clear already in the late nineties and has been confirmed by the fact that an ever-increasing petrol price it is not a widespread demand, even from political forces very concerned about global warming. As we will see below, the few attempts of implementing a fuel tax has up to now been defeated by popular resistance. Secondly, in order to avoid “carbon leakage”, that is firms moving to countries without a carbon price, a generous amount of free emissions was given for free to for example the steel industry. This was in fact a direct subsidy, since the steel industry could sell the emissions rights, which even at a low price would generate enormous sums of money. Thirdly, there were the “off-sets”, in particular the “Clean Development Mechanism” (CDM). Off-sets are hypothetical reductions given contra-factual that would not have been made if the creator of off-sets could not sell those emission rights and be able to buy new and “greener” technology, that is the principle of “additionality”. The fundamental problems with off-sets were pointed out from the start and experiences fully confirmed this, as pointed out by among many [8], various authors in [2], or [9]. The unavoidable result of the fraud and scandals connected to the CMD was that the use of such obviously dubious off-sets was banned from the EU ETS – and their price collapsed.

### 3.7 The Allowance Surplus and the Reform Period

The loopholes worked as intended, the danger of a high, not to speak about a rising carbon price as the “cap” was lowered was completely avoided. The loopholes secured a continuous oversupply which meant that the price per ton CO<sub>2</sub> from 2012 – 2017 were between 5 and 10 Euros, far from the initial “close to 30 Euros” when the system was new in 2008. That is before the market learned about the oversupply. There is a huge literature on the reform period from 2013 onwards. “Rescuing EU Emissions Trading: Mission Impossible?” was the title of an article of [9]. For the non-expert, the publications from non-profit think tanks like [6] describe in a clear non-expert prose why the surplus exists and proposes how to “fix” the EU ETS, cf. [6]. The proposed reforms are very straight forward, like no more free allowances, decreasing the amount of emissions allowed per year (the “cap”) faster, technically speaking increasing the “linear reduction factor”, the “destruction” of some of the current surplus, just to mention the most important proposals. The key instrument that came out of years of negotiations between the Parliament that wanted more radical reforms and the Commission was the Market Stability Reserve, the MSR. The stated intention of the MSR is to avoid a very low carbon price that is between 5 to 10 Euros. Such low prices will probably be avoided. But confirming our hypothesis that there is no real will among the ruling elites to have an ever-increasing carbon price, the MSR is constructed so that you will not “tighten” the EU ETS sufficiently. There will still be a continuous surplus of allowances to make the price “ineffective” that is not having any impact on the emissions anywhere close to what is needed according to the Paris agreement and the latest IPCC special report on the 1.5 degree limit. In a recent working paper, two researchers at the Danish Climate Council used simulation

to analyse the effect of the compromise reached by the EU Parliament and the EU Commission in June 2018 on the EU ETS in the coming decade(s). Their main conclusion is not at all surprising “The model simulations indicate that the current allowance surplus may not disappear until sometime in the 2050s if no further tightening of allowance supply is undertaken”, [1]. If we suppose that the MSR will continue to give a carbon price around 20 Euro per tonne, this is still not more than roughly 5 cents per litre of petrol, which will have some effect on emissions, but not anyway near what is needed. The Stern&Stiglitz report writes that “analysts suggest that the drop in the European Union (EU) Emissions Trading System (ETS) emissions (by 2.4 percent in 2016) was primarily driven by the carbon-price floor introduced in the United Kingdom, where a £18/tCO<sub>2</sub> top-up on the EU ETS price resulted in the coal power plants reducing their emissions by 58 percent in 2016.” The irony is that a £18 price floor is just another name for a tax, it is unaffected by the supply and demand of allowances. The UK is not the only country seeing the necessity and advantages of a stable carbon price around 20 Euro or higher. Carbon Pulse on October 11th 2018, reported that Switzerland, the Netherlands and California were planning to introduce a floor. Internationally, since 2008 the carbon tax system in British Columbia, where tax income has been redistributed, was for a long time the “beacon” a “carbon fee and dividend” system. In October 2018, Canada’s prime minister Justin Trudeau, announced that a carbon fee and dividend system would be the national “default” policy if the regions did not have their own carbon pricing systems [4].

## 4 Discussion

As pointed out above, from 2012 and to the first months of 2017 the price was hovering mostly just above 5 Euros. As the outline of the new setup of the EU ETS started to emerge in the Spring 2017, the EU carbon price started to rise and reached 26 Euro in early September. As predicted by our hypothesis that strong forces are working against a high and steadily rising carbon price, already on the 13th of December, Carbon Pulse reported that “Poland’s energy minister on Thursday urged Brussels to step in to cool EU ETS prices, which this week spiked to a 10-year high near €26, Polish newswire PAP reported.” Poland also took steps on its own to cool prices by announcing to “Poland to nearly double 2019 auction quota with surprise EUA sale notice” was a headline in Carbon Pulse December the 5th. Poland is of course not alone. The dominant policy in Germany is to continue and expanding coal mining as nuclear power is being phased out, the so-called *Energiewende*. There is at the same time in Germany a rising resistance to this expansion of especially open day mining, and the climate movement won a small victory when the Hambacher Wald was not cut destroyed in order to expand day-mining. If the resistance to increased use of lignite is effective in reducing supply – this will also result in rising prices – which also will be socially unjust and result in clash of interests between the climate movement and ordinary people.

The resistance to unjust, flat tax increases has got its clearest expression in the failed attempts of three French presidents to have a carbon tax on fuel. On 23rd of March 2010 a headline in the British newspaper The Telegraph (2010) was “France ditches carbon tax as social protests mount”, so Sarkozy failed. Hollande tried four years later. The Guardian headline was “French eco tax mobilises new generation of Breton red caps” (<https://www.theguardian.com/world/2014/jan/03/french-eco-tax-new-generation-breton-red-caps>). As we were finishing this paper, the protest against the eco-tax on fuel announced by president Macron unleashed a protest movement of an order of magnitude and political importance. The movement of the “yellow vests” (gilets jaunes) seemed to start out as only a right-wing populist anti-tax movement, but it soon developed more demands – some of them of a clearly more left wing character. It is of course too early – and not the aim of this paper to analyse the “yellow vest” movement in any detail. The point is that without taking the income effects and the resulting political effects of a high carbon price into consideration one cannot formulate a climate policy that will mobilize enough popular support to “do the job”, that is reducing the emission by 50 % by 2030 [5].

## **5 Conclusion - the End of the World versus the End of the Month**

As a way of concluding we think the new saying that emerged from the yellow vests movement to care about the end of the world or the end of the month really is the Gordian Knot of climate policy. Most people do care about both and the key to mobilising them is to align their short term economic interests with their long term interest in a stable climate. Peoples interest in a stable climate makes a rising carbon price mandatory and the only way get them to support at rising carbon price is that they benefit in the short run if they support that. This makes a progressive carbon tax the only way to cut the Gordian knot.

The result of the last COP24 in Katowice showed that the more or less democratically elected leaders still do not dare to rise the carbon price. The indicator that literally speaks huge volumes of CO<sub>2</sub> emissions is that the fraudulent sale of “offsets”, the Clean Development Mechanism was not abolished. So the old and tried loophole for those who do not want to reduce emissions “at home” and solve that problem by “indulgences trade” are still allowed to continue with a low carbon price at home. This kind of “free-riding” of course has a devastating effect on all efforts to have collective action to reduce emissions. The solution to that problem is as Nordhaus as analysed thoroughly is to create a “carbon club” and have carbon import tariffs penalizing the countries that do not have carbon pricing at a sufficient level. But in order to create a carbon club, a sufficient number of countries, that means ordinary people in a sufficient number of countries must mobilise in favour of a progressive carbon tax – spes uniqa.

## References

1. Australia outlines conditions for joining Kyoto protocols second commitment period, <http://sdg.iisd.org/news/australia-outlines-conditions-for-joining-kyoto-protocols-second-commitment-period>, last accessed 2018/11/11.
2. Böhm, S., Dabhi, S.: *Upsetting the Offset: The Political Economy of Carbon Markets*. 1st ed. MayFlyBooks: London (2009).
3. CISDL: The Principle of Common But Differentiated Responsibilities: Origins and Scope, [http://cisdl.org/public/docs/news/brief\\_common.pdf](http://cisdl.org/public/docs/news/brief_common.pdf), last accessed 2018/11/02.
4. Citizens' Climate Lobby Canada: Canada adopts carbon fee and dividend to rein in climate change, [https://canada.citizensclimatelobby.org/media-release-canada-adopts-carbon-fee-and-dividend-to-rein-in-climate-change/?fbclid=IwAR1ZjALw-iJcSg8wwYk8nTNtfcZZTKI9L-zwEJHrl\\_rPdQEXkm\\_EwmhJQg](https://canada.citizensclimatelobby.org/media-release-canada-adopts-carbon-fee-and-dividend-to-rein-in-climate-change/?fbclid=IwAR1ZjALw-iJcSg8wwYk8nTNtfcZZTKI9L-zwEJHrl_rPdQEXkm_EwmhJQg), last accessed 2018/10/28.
5. France ditches carbon tax as social protests mount, <https://www.telegraph.co.uk/finance/newsbysector/energy/7507015/France-ditches-carbon-tax-as-social-protests-mount.html>, last accessed 2018/11/10.
6. Sandbag: An agenda for strategic reform of the ETS: What's the future for EU carbon pricing? <https://sandbag.org.uk/wp-content/uploads/2017/12/Strategic-Reform-of-the-ETS-2017-Sandbag-1.pdf>, last accessed 2018/11/03.
7. Skjærseth, J. B., Wettstad, J.: Making the EU Emissions Trading System: The European Commission as an Entrepreneurial Epistemic Leader. *Global Environmental Change*, 20(2), 314-321 (2010). DOI <https://doi.org/10.1016/j.gloenvcha.2009.12.005>.
8. Wara, M.: Measuring the Clean Development Mechanism's Performance and Potential. *UCLA Law Review*, 55(6), 1759-1803 (2008).
9. Wettstad, J.: Rescuing EU Emissions Trading: Mission Impossible? *Global Environmental Politics*, 14(2), 64-81 (2014). DOI [https://doi.org/10.1162/GLEP\\_a\\_00229](https://doi.org/10.1162/GLEP_a_00229).
10. World Bank: Report of the High-Level Commission on Carbon Prices. 1st ed. World Bank: Washington, DC (2017).

# Analysis of Decoupling Effect of China's Agricultural Carbon Emission

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**Abstract.** In this paper, the improved Divisia exponential decomposition method is adopted to decompose the driving factors of agricultural carbon emission growth into six major effects of theoretical carbon emission increase and theoretical carbon emission reduction. This paper analyzed the driving effect and decoupling state of China's agricultural carbon emission growth from 2000 to 2016 and found that the rapid growth of China's agricultural carbon emission over the long term was mainly caused by the slow inhibition of the effect of theoretical carbon emission reduction and the effect of theoretical carbon emission increase, China's agricultural carbon emissions and economic growth maintain a stable state of weak decoupling and have the potential to develop into a strong decoupling; Agricultural energy consumption efficiency, agricultural technological progress and improvement of farmers' living conditions are important policies to realize the ideal decoupling between agricultural carbon emissions and economic growth.

**Keywords:** Decoupling Effect, Carbon Emissions, Economic Growth.

## 1 Introduction

There are many domestic studies on the decoupling of carbon emissions from economic growth. For example, Ding Hao and Dai Rufeng [3] found that China's petrochemical industry was developing rapidly and its energy consumption increment was at a low level through establishing a 10-year carbon emission decoupling model; Liu Weibo [5] studied the output efficiency based on carbon emission constraint according to the industrial data of Henan province from 2000 to 2010 and put forward the specific ideas and countermeasures for adjusting industrial structure; Bai Juan [1] studied the factors influencing the decoupling of carbon emission from economic growth in China's transportation industry from 1995 to 2014 and their dynamic mechanism of action, they all used the basic decoupling theory to study the decoupling of industry carbon emissions from economic growth. In the study of agricultural carbon emissions, Zhang Yumei and Qiao Juan [8] used Tapio elastic analysis to analyze the relationship between urban agricultural development and agricultural carbon emissions in Beijing, and found that animal husbandry contributed the most to agricultural emissions reduction. Zhang Junbiao and Wu Xianrong's research [9] is more comprehensive,

using an improved Divisia exponential decomposition, they divided the growth drivers of agricultural carbon emissions in China's provinces between 2002 and 2014 into five parts and concluded that the imbalance between the development of rural living standards and the regional development of low carbon agricultural technology is an important factor for the large difference in agricultural carbon emissions between regions. Shi Changliang et al. [7] used the LMDI decomposition method to conduct a quantitative analysis of China's agricultural energy consumption carbon emission over the past 30 years, and found that the decoupling state stability of China's energy consumption carbon emission from agricultural economic growth was poor.

It can be found that domestic research on carbon emission decoupling involves various fields, which are basically divided into two categories: one is the research on energy consumption carbon emission of a certain industry, and the other is the research on the relationship between carbon emission and economic growth of the industry. In the literature of agricultural carbon research, lack of their study is that without the energy consumption of agriculture and agricultural carbon decoupling research combine together, and the innovation of this paper lies in: the energy consumption of agriculture decoupling effect of the variable into the research of agricultural carbon decomposition model, a more comprehensive analysis of agricultural carbon emissions growth driving effect of the composition and the effect of decoupling state changes.

Therefore, this paper mainly USES the improved exponential decomposition method to decompose the decoupling effect of China's provincial carbon emission growth and studies the driving effect of the decoupling effect of each part.

## 2 Theories and Methods

### 2.1 Measurement of Agricultural Carbon Dioxide Emissions

The research on the measurement of agricultural carbon dioxide emissions at home and abroad is rather detailed. According to the specific practice in previous literature Tian Yun [6] this paper comprehensively and precisely classifies and calculates the carbon emissions of three parts of agriculture, and calculates and adds up the total amount of carbon emissions according to the IPCC(2006) carbon emission calculation formula [4]:

$$E = \sum_{i=1}^n E_i = \sum_{i=1}^n T_i \cdot \alpha \quad (1)$$

where  $E$  donates the total agricultural carbon emissions (unit: kg),  $E_i$  is agricultural carbon emissions of different carbon emission resources,  $T_i$  is the specific quantities or indicators of agricultural resources,  $\alpha$  is the carbon emission coefficient of various agricultural resources.

## 2.2 Tapio Decoupling Model

**Decoupling concept.** The word "decoupling" originally refers to the falling off of the link between trains. The OECD introduced the concept of decoupling into agricultural policy research at the end of the 20th century and gradually expanded it into areas such as the environment. Besides, "Carbon decoupling" is an idealized process in which the relationship between economic growth and greenhouse gas emissions is constantly weakened or even disappeared, that is, on the basis of economic growth, energy consumption is gradually reduced.

**Decoupling criteria.** The Tapio decoupling index analyzes the decoupling relationship between variables through the concept of "elasticity", which refers to the property that a variable changes in proportion to another variable. The definition is:

$$e = \frac{\Delta CO_2 / CO_2}{\Delta GDP / GDP} \quad (2)$$

where  $e$  is denotes the decoupling elasticity,  $CO_2$  is agricultural carbon emissions,  $GDP$  is the total agricultural output. It can be found that the concept of elastic analysis can eliminate the dimensional constraints on decoupling elasticity, and the factor decomposition of decoupling index can be carried out by introducing one or more intermediate variables to facilitate the mathematical transformation and in-depth analysis.

## 2.3 Factor Decomposition of Decoupling Effect

Based on the original Kaya identities, due to the agricultural carbon emissions associated with the provinces domain agriculture total energy consumption, namely agricultural energy consumption is an important variable affecting agricultural carbon emissions, so this article is in Wu Xianrong decomposition based on the identity of the introduction of agricultural energy consumption such as variable ( $E_i$ ) of agricultural carbon emissions of Chinese provinces domain driven factors are further broken down as follows: [9]

$$C = \sum_i C_i = \sum_i \frac{C_i}{E_i} \times \frac{E_i}{K_i} \times \frac{K_i}{Y_i} \times \frac{Y_i}{R_i} \times \frac{R_i}{P_i} \times P_i = \sum_i c_i \cdot e_i \cdot k_i \cdot y_i \cdot r_i \cdot p_i \quad (3)$$

where,  $C_i$  refers to total agricultural carbon emission,  $E_i$  is the total agricultural energy consumption,  $K_i$  is the total agricultural production input,  $Y_i$  is the total agricultural output,  $R_i$  is the rural population and  $P_i$  is the total population.  $c_i = C_i / E_i$  is the carbon efficiency,  $e_i = E_i / K_i$  is the indirect energy consumption intensity,  $k_i = K_i / Y_i$  is the agricultural input output ratio,  $y_i = Y_i / R_i$  is the gross output per capital of agricultural,  $r_i = R_i / P_i$  is the reverse urbanization level, and  $p_i = P_i$  is the population size.

So *formula(3)* said: agricultural emissions into - carbon energy efficiency effect, indirect energy consumption intensity effect, technology effect, farmers life

improvement effect, reverse effects of urbanization and population scale effect the product of the six effect, i.e., the change of agricultural carbon emissions depends on the change of the six parts effect.

By using the LMDI addition and analysis method, the change amount of agricultural carbon emissions relative to the base period can be expressed as the following formula:

$$\begin{aligned}\Delta C &= C_t \cdot C_0 \\ \Delta C &= \sum c_{i,t} \cdot e \cdot k_t \cdot y_t \cdot r_t \cdot p_t \cdot \sum c_{i,0} \cdot e_0 \cdot k_0 \cdot y_0 \cdot r_0 \cdot p_0 \\ \Delta C &= \Delta C_c + \Delta C_e + \Delta C_k + \Delta C_y + \Delta C_r + \Delta C_p + \Delta C_\phi\end{aligned}\quad (4)$$

whereas,  $\Delta$  represents the agricultural carbon emissions generated by the six effects respectively,  $\Delta C_\phi$  represents the agricultural carbon emissions generated by the six effects respectively, is the decomposition residue, and represents the part that may lead to the increase or decrease of agricultural carbon emissions except the six effects.

The six effects of the above exponential decomposition also have the following economic implications:

- Agricultural energy carbon emission efficiency effect,  $\Delta C_c$

Its value depends on two variables: total agricultural carbon emissions and agricultural energy consumption, which measures the amount of carbon emitted per unit of agricultural energy consumption. As the size of agricultural carbon emissions also depends on the size of agricultural energy consumption in the region, for two regions with the same agricultural energy consumption level in the same period, the smaller the carbon emission value reflects the smaller impact of agricultural energy emissions on environmental pollution in the region.

- Agricultural indirect energy consumption intensity effect,  $\Delta C_e$

The value depends on two variables: total agricultural carbon emissions and agricultural energy consumption, which measures the amount of carbon emitted per unit of agricultural energy consumption. The size of agricultural carbon emissions also depends on the amount of energy consumed by the region's agriculture.

- Agricultural technological progress effect,  $\Delta C_k$

It is the input/output ratio of agriculture that affects the change of its value. As the innovation of agricultural technology is an important link of energy conservation and emission reduction, it is reflected in the application and popularization of agricultural emerging technologies, which will improve the efficiency of agricultural utilization of natural resources and cause the change of agricultural carbon emissions, so it is the effect of agricultural technological progress.

- Improvement effect of farmers' life,  $\Delta C_y$



It is the "per capital output value effect", which is reflected in the improvement of farmers' living conditions. As a result of the rapid development of economy, urban water, electricity and gas can be introduced into rural areas, improving farmers' quality of life. Meanwhile, the use of water, electricity and gas will also bring more carbon emissions.

- Reverse urbanization effect,  $\Delta C_r$

The numerical value is the ratio of rural population to total population, while the reverse urbanization value decreases as the proportion of rural population to total population decreases. At this time, more and more people move to cities, leading to the increase of urban carbon emission, while the carbon emission in rural areas may be controlled.

- Population size effect,  $\Delta C_p$

This is reflected in the driving effect of population on agricultural carbon emissions. With the increase of population, it is inevitable to increase agricultural production input to meet the increase of demand for agricultural products. The increase of agricultural production input will inevitably lead to the increase of agricultural energy consumption, and eventually to the increase of agricultural carbon emissions.

Then, the factors of *formula(3)* were decomposed and the derivative was obtained, and the following formula was obtained:

$$\begin{aligned} \frac{dC}{dt} = & \sum_i \frac{c_i}{dt} \cdot e \cdot k \cdot y \cdot r \cdot p + \sum_i c \cdot \frac{e_i}{dt} \cdot k \cdot y \cdot r \cdot p + \sum_i c \cdot e \cdot \frac{k_i}{dt} \cdot y \cdot r \cdot p + \sum_i c \cdot e \cdot k \cdot \frac{y_i}{dt} \cdot r \cdot p + \\ & \sum_i c \cdot e \cdot k \cdot y \cdot \frac{r_i}{dt} \cdot p + \sum_i c \cdot e \cdot k \cdot y \cdot r \cdot \frac{p_i}{dt} \end{aligned} \quad (5)$$

divide both sides of this equation by C, and you get:

$$\begin{aligned} \frac{1}{C} \cdot \frac{dC}{dt} = & \sum_i \frac{1}{c_i} \cdot \frac{dc_i}{dt} \cdot \frac{c_i}{C} \cdot e \cdot k \cdot y \cdot r \cdot p + \sum_i c \cdot \frac{1}{e_i} \cdot \frac{de_i}{dt} \cdot \frac{e_i}{C} \cdot k \cdot y \cdot r \cdot p + \sum_i c \cdot e \cdot \frac{1}{k_i} \cdot \frac{dk_i}{dt} \cdot \frac{k_i}{C} \cdot y \cdot r \cdot p \\ & + \sum_i c \cdot e \cdot k \cdot \frac{1}{y_i} \cdot \frac{dy_i}{dt} \cdot \frac{y_i}{C} \cdot r \cdot p + \sum_i c \cdot e \cdot k \cdot y \cdot \frac{1}{r_i} \cdot \frac{dr_i}{dt} \cdot \frac{r_i}{C} \cdot p + \sum_i c \cdot e \cdot k \cdot y \cdot r \cdot \frac{1}{p_i} \cdot \frac{dp_i}{dt} \cdot \frac{p_i}{C} \end{aligned} \quad (6)$$

by integrating the above *equation (6)* with the definite integral of 0-t, the following formula can be obtained:

$$\frac{d \ln C}{dt} \cdot dt = \sum_i \frac{c \cdot e \cdot k \cdot y \cdot r \cdot p}{C} \left( \frac{d \ln c}{dt} + \frac{d \ln e}{dt} + \frac{d \ln k}{dt} + \frac{d \ln y}{dt} + \frac{d \ln r}{dt} + \frac{d \ln p}{dt} \right) dt \quad (7)$$

and let  $T_i = (c \cdot e \cdot k \cdot y \cdot r \cdot p) / C$ , and the above *equation (7)* can be rewritten as:

$$\begin{aligned} \frac{C_t}{C_0} = & \exp\left(\sum_i T_i \cdot \ln \frac{c_t}{c_0}\right) \cdot \exp\left(\sum_i T_i \cdot \ln \frac{e_t}{e_0}\right) \cdot \exp\left(\sum_i T_i \cdot \ln \frac{k_t}{k_0}\right) \cdot \exp\left(\sum_i T_i \cdot \ln \frac{y_t}{y_0}\right) \cdot \\ & \exp\left(\sum_i T_i \cdot \ln \frac{r_t}{r_0}\right) \cdot \exp\left(\sum_i T_i \cdot \ln \frac{p_t}{p_0}\right) \end{aligned} \quad (8)$$

taking the logarithm of both sides of the equation, we can get:

$$\ln \frac{C_t}{C_0} = \sum_i T_i \cdot \ln \frac{c_t}{c_0} + \sum_i T_i \cdot \ln \frac{e_t}{e_0} + \sum_i T_i \cdot \ln \frac{k_t}{k_0} + \sum_i T_i \cdot \ln \frac{y_t}{y_0} + \sum_i T_i \cdot \ln \frac{r_t}{r_0} + \sum_i T_i \cdot \ln \frac{p_t}{p_0} \quad (9)$$

as  $C_t - C_0 = \Delta C_{total}$ , let  $M = \frac{C_t - C_0}{\ln(C_t/C_0)}$ , then the corresponding increment of each factor can be obtained:

$$\Delta C_{total} = M \cdot \ln \frac{C_t}{C_0} \left\{ \begin{array}{l} \Delta C_c = M \cdot \ln \frac{c_t}{c_0} \\ \Delta C_e = M \cdot \ln \frac{e_t}{e_0} \\ \Delta C_k = M \cdot \ln \frac{k_t}{k_0} \\ \Delta C_y = M \cdot \ln \frac{y_t}{y_0} \\ \Delta C_r = M \cdot \ln \frac{r_t}{r_0} \\ \Delta C_p = M \cdot \ln \frac{p_t}{p_0} \end{array} \right. \quad (10)$$

therefore, carbon emissions can be expressed as:

$$\Delta C = C_t - C_0 = \Delta C_c + \Delta C_e + \Delta C_k + \Delta C_y + \Delta C_r + \Delta C_p \quad (11)$$

based on the above formula, the decoupling model of agricultural carbon emissions and economic growth can be decomposed into:

$$\begin{aligned} \gamma(CO_2, GDP) &= \frac{\Delta CO_2 / CO_2}{\Delta GDP / GDP} = (\Delta C_c + \Delta C_e + \Delta C_k + \Delta C_y + \Delta C_r + \Delta C_p) \cdot \frac{GDP}{CO_2 \cdot \Delta GDP} \\ &= \frac{\Delta C_c / C}{\Delta GDP / GDP} + \frac{\Delta C_e / C}{\Delta GDP / GDP} + \frac{\Delta C_k / C}{\Delta GDP / GDP} + \frac{\Delta C_y / C}{\Delta GDP / GDP} + \frac{\Delta C_r / C}{\Delta GDP / GDP} + \frac{\Delta C_p / C}{\Delta GDP / GDP} \end{aligned} \quad (12)$$

that is,

$$\gamma = \gamma_c + \gamma_e + \gamma_k + \gamma_y + \gamma_r + \gamma_p \quad (13)$$

from formula (13), we can clearly see that China's agricultural carbon emissions and decoupling of economic growth elasticity index ( $\gamma(CO_2, GDP)$ ) can be decomposed into carbon efficiency elasticity of decoupling, indirect energy consumption intensity of decoupling elasticity, the elasticity of input and output decoupling, the output value per capital decoupling elasticity, reverse decouple decoupling elasticity of urbanization and population scale elasticity, and respectively by six indicators  $\gamma_c, \gamma_e, \gamma_k, \gamma_y, \gamma_r, \gamma_p$ .

## 2.4 Data

This paper selects China's agricultural carbon emission data from 2000 to 2016 for calculation, the data of agricultural pesticides, agricultural film, etc. in farmland life

utilization, the data of paddy field planting area and the data of livestock (cattle, horses, donkeys, etc.) are from *China Rural Statistical Yearbook (2000-2016)*. The data of agricultural production input, total agricultural output value and total population in China from 2000 to 2016 adopted in this paper are from *National Bureau of Statistics of China*. The data of agricultural energy consumption is calculated by the author based on the existing data of *China Energy Statistical Yearbook*. [2]

### 3 Results and Discussion

#### 3.1 Analysis of the Decoupling Effect of China's Agricultural Carbon Dioxide Emissions

According to the economic implications of these six effects, it is easy to judge that in the rapid development of China's agricultural economy, the improvement effect of farmers' lives and the effect of population size are two important factors that cannot be ignored, which are regarded as the theoretical increase of agricultural carbon emissions. The four effects of agricultural energy carbon emission efficiency effect, agricultural indirect energy consumption intensity effect, general agricultural technological progress effect and reverse urbanization effect can be improved in some way to reduce agricultural carbon emissions. Therefore, we regard these four effects as theoretical reduction of agricultural carbon emissions.

**Table 1.** China's agricultural carbon emission driving effect factor decomposition. (unit: 10,000 tons of standard CO<sub>2</sub>).

year	$\Delta C$	$\Delta C_c$	$\Delta C_e$	$\Delta C_k$	$\Delta C_y$	$\Delta C_r$	$\Delta C_p$
2001	-2,101.87	-7,706.14	1,074.76	422.96	5,675.04	-2,254.75	686.27
2002	-782.48	-9,184.95	3,745.71	1,553.58	4,733.42	-2,257.92	627.67
2003	-2,358.66	-16,747.38	2,200.06	12,583.03	1,321.48	-2,290.89	575.05
2004	3,729.26	-11,277.86	-3,001.99	-1,143.27	20,600.71	-2,014.36	566.02
2005	1,099.67	-11,414.90	-1,349.57	6,137.71	9,253.74	-2,109.48	582.17
2006	-258.66	-9,358.63	9,949.36	-10,067.17	11,077.75	-2,383.82	523.86
2007	1,430.82	-6,914.07	-10,389.46	5,155.60	15,875.60	-2,812.72	515.87
2008	1,495.06	-1,444.04	-15,220.58	5,125.68	14,600.25	-2,080.89	514.63
2009	1,791.98	-3,072.57	1,061.57	-5,770.56	11,732.28	-2,659.80	501.05
2010	989.89	-6,356.63	-6,637.75	-5,060.20	21,843.62	-3,299.07	499.93
2011	776.67	-6,654.90	-9,359.96	3,316.43	15,784.41	-2,813.40	504.10
2012	919.21	-3,138.64	-5,764.70	-2,001.24	14,165.95	-2,867.49	525.32
2013	899.85	-2,959.89	-4,453.37	-1,597.80	12,032.18	-2,647.70	526.43
2014	957.12	-1,320.23	-3,314.86	-1,058.71	8,543.98	-2,454.60	561.53

2015	412.50	-627.81	-4,534.19	39.62	8,236.03	-3,239.64	538.48
average	600.02	-6,545.24	-3,066.33	509.04	11,698.43	-2,545.77	549.89

According to the data in the table, except for the two periods from 2002 to 2003 and 2005 to 2006, China's agricultural carbon emissions have basically been increasing at a high speed since the 21st century. In particular, from 2007 to 2009, agricultural carbon emissions increased significantly, reaching 1,791.98 (10,000 tons of standard CO<sub>2</sub>) in 2009. The drastic reduction of China's agricultural carbon emissions in 2000-2001 was attributed to a series of energy-saving and emission reduction laws and regulations and policy measures implemented in 1998, which effectively reduced China's total agricultural carbon emissions. Similarly, the initial implementation effect of the "11th five-year plan" in 2006 was obvious, with agricultural carbon emissions falling by 258.66 (10,000 tons of standard CO<sub>2</sub>) year-on-year. From the horizontal observation, we can find that the efficiency effect of agricultural energy carbon emission, the intensity effect of agricultural indirect energy consumption and the reverse urbanization effect have a stable negative driving effect on agricultural carbon emission over a long period of time.

It can also be found from the data in **Table 1**, that the growth of China's agricultural carbon emissions is basically driven by the high speed of part effect of theoretical increase and the slow drive of part effect of theoretical reduction. The rapid development of China's economy and the improvement of people's living standards since the 21st century are reflected in the significant positive promoting effect of the improvement effect of farmers' lives on China's agricultural carbon emissions. In 2010, its contribution to agricultural carbon emissions reached the peak, with year-on-year growth of 21,843.62 (10,000 tons of standard CO<sub>2</sub>). The effect of agricultural technological progress on agricultural carbon emissions is not stable, and will promote the increase of agricultural carbon emissions, which aims to show that while focusing on improving agricultural production technologies, we should also vigorously advocate the concept of energy conservation and emission reduction, and improve the efficiency of resource utilization.

### 3.2 Decoupling of Carbon Emissions

**Table 2.** The decoupling of national agriculture carbon emissions from economic growth in 2000-2016.

year	$\Delta\text{CO}_2/\text{CO}_2$	$\Delta\text{GDP}/\text{GDP}$	elasticity	Decoupling state	Economic meaning
2000-2001	-0.0211	0.0425	-0.4960	strong decoupling	Carbon emissions are falling and the economy is growing
2001-2002	-0.0080	0.0324	-0.2472		
2002-2003	-0.0243	-0.0041	5.9200	recession decoupling	The rate of reduction in

					carbon emissions exceeds the rate of economic decline
2003-2004	0.0394	0.2198	0.1795		The economic growth rate exceeds the carbon emission growth rate
2004-2005	0.0112	0.0813	0.1376	weak decoupling	Carbon emissions are falling and the economy is growing
2005-2006	-0.0026	0.0973	-0.0267	strong decoupling	
2006-2007	0.0144	0.1457	0.0991		
2007-2008	0.0149	0.1373	0.1083		
2008-2009	0.0176	0.0975	0.1802		
2009-2010	0.0095	0.2003	0.0476	weak decoupling	The economic growth rate exceeds the carbon emission growth rate
2010-2011	0.0074	0.1366	0.0542		
2011-2012	0.0087	0.1179	0.0738		
2012-2013	0.0084	0.0971	0.0870		
2013-2014	0.0089	0.0636	0.1401		
2014-2015	0.0038	0.0523	0.0728		
2015-2016	-0.0524	0.0287	-1.8272	strong decoupling	Carbon emissions are falling and the economy is growing

On the whole, China's agricultural carbon emissions in 2000-2016 have been weakly decoupled from economic growth. The decoupling effect of agricultural development from 2000 to 2002 in strong decoupling by 2003 as the recession decoupling, the agricultural economic growth and energy conservation and emissions reduction effect is remarkable, even in 2003 brief decline in agricultural economy, agricultural carbon emissions is still obvious energy saving effect, thanks to China implemented on January 1, 1998 of the energy conservation law of the People's Republic of China and after a series of energy conservation and emissions reduction laws enacted.

From the decoupling state, although China's agricultural weak decoupling state is very stable, but there is a certain potential to develop strong decoupling. From 2005 to 2006 and from 2015 to 2016, three periods of agriculture in China are presented strong decoupling state, decoupling state is ideal, in 2006 and 2016, respectively, for the eleventh five-year plan in China and starting year "much starker choices-and graver consequences-in planning", clearly China's vision of the country's economic development has made the effective planning, green low carbon development has made some achievements, in response to the problem of global warming contribute force to

be reckoned with. In 2016, with the progress of science and technology and the implementation of related policies, agricultural carbon decoupling is sustained strong decoupling of the ideal state, depending on the theory of agricultural carbon emission reduction four inhibition effect, improve agricultural technology progress by promoting agricultural technological innovation, and by improving the agricultural energy efficiency to reduce carbon emissions is effective and feasible measures.

From the perspective of the concrete numerical value of elasticity of decoupling, Chinese agriculture weak decoupling state for a long time, before 2008, weak decoupling elasticity has been slowly rising steadily, and from 2008 to 2010, the weak decoupling of elasticity decreased from 0.180 to 0.048, is affected by the financial crisis of 2008, China's agricultural products prices are falling, farmer production enthusiasm decline, agricultural technology advancement effect and improve farmers life effect both promote decline, although led to a decline in agriculture decoupling elasticity, but still keep the weak state of decoupling, consumes a lot of energy at the same time does not keep a higher level of economic growth.

### 3.3 Comparative Analysis of Decoupling Elasticity

Based on the addition and decomposition of the national agricultural data by the exponential decomposition method, the decoupling elasticity of the driving factors for the growth of agricultural carbon emission in each part is obtained. The results are as follows:

**Table 3.** Agricultural carbon growth effect decoupled elasticity.

year	$\gamma_c$	$\gamma_e$	$\gamma_k$	$\gamma_y$	$\gamma_r$	$\gamma_p$
2001	-1.82	0.25	0.1	1.34	-0.53	0.16
2002	-2.9	1.18	0.49	1.5	-0.71	0.2
2003	-1.72	-5.52	0.22	-3.32	5.75	-1.44
2004	-0.54	-0.14	-0.06	0.99	-0.1	0.03
2005	-1.43	-0.17	0.77	1.16	-0.26	0.07
2006	-0.97	1.03	-1.04	1.15	-0.25	0.05
2007	-0.48	-0.72	0.36	1.1	-0.19	0.04
2008	-0.1	-1.1	0.37	1.06	-0.15	0.04
2009	-0.31	0.11	-0.58	1.18	-0.27	0.05
2010	-0.31	-0.32	-0.24	1.05	-0.16	0.02
2011	-0.46	-0.65	0.23	1.1	-0.2	0.04
2012	-0.25	-0.46	-0.16	1.14	-0.23	0.04
2013	-0.29	-0.43	-0.15	1.16	-0.26	0.05

2014	-0.19	-0.49	-0.16	1.25	-0.36	0.08
2015	-0.11	-0.8	0.01	1.45	-0.57	0.1

Based on the decoupling of the driving factors of China's agricultural carbon emissions and economic growth from 2000 to 2015, it is found that:

(i) On the whole, among the decoupling elasticity of six major driving effects of agricultural carbon emission, the decoupling elasticity of agricultural energy carbon emission efficiency elasticity and reverse urbanization effect basically maintains a stable strong decoupling state, indicating that the relationship between the driving amount of agricultural carbon emission and economic growth has reached an ideal state.

(ii) Indirect effects of energy consumption intensity of agriculture and agricultural technology progress effect and size effect of the elastic state basic transformation between strong decoupling and weak decoupling, speculated that China's agriculture in the two aspects of indirect energy consumption intensity and technological progress to adjust to achieve the ideal of strong decoupling condition is feasible, therefore, push forward the reform of agricultural energy consumption structure and technological innovation is due, can practice the policy of energy saving and emission reduction measures;

(iii) The decoupling elastic state of the improvement effect of farmers' lives was in the growth connection state between 2003 and 2013, that is, the agricultural carbon emission and economic level were both in the growth state, while the decoupling elastic value between 2000 and 2002 and 2013 and 2015 was greater than 1.2, which represented the expansion negative decoupling, and its economic implication was as follows: Farmers life improvement effect driven by carbon emissions growth rate exceeded the rate of economic growth, and this state is not in conformity with the concept of sustainable development, thus to promote energy conservation and emissions reduction and recycling of the concept of green agricultural products to set up the rural people's consciousness of energy conservation and environmental protection, while economic growth slow the growth of agricultural carbon emissions of life appropriately.

## 4 Conclusion

- In the analysis of the decomposition of the driving factors of agricultural carbon emissions in China from 2001 to 2015, we classify them into two categories. Compared with the results of Wu Xianrong's decomposition of the driving factors of agricultural carbon emissions in China's provinces, the driving directions of the five effects are consistent with the results of his analysis (except for the newly introduced indirect energy consumption intensity effect), indicating that the analysis results of this paper are of certain reliability.

- From the results of quantitative analysis, we can find that the drastic reduction of China's agricultural carbon emissions in 2000-2001 was largely attributed to the series of laws and regulations on energy conservation and emission reduction initiated by China in 1998 and the policy measures adopted. Similarly, the preliminary implementation of China's 11th five-year plan in 2006, while ensuring the steady development of China's agriculture, has gradually implemented the low carbon policy and achieved remarkable results. Agricultural carbon emissions in that year decreased by 2,586,600 (10,000 tons of standard CO<sub>2</sub>).
- The growth of China's agricultural carbon emissions is basically driven by the high speed of partial effect of theoretical increase and the slow drive of partial effect of theoretical reduction. The rapid development of China's economy and the improvement of people's living standards since the 21st century are reflected in the significant positive contribution of improvement effect of farmers' life to China's agricultural carbon emissions. In 2010, its contribution to agricultural carbon emissions reached the peak, with year-on-year growth of 21,843.62 (10,000 tons of standard CO<sub>2</sub>). The effect of agricultural technological progress on agricultural carbon emissions is not stable, and will promote the increase of agricultural carbon emissions, which aims to show that while focusing on improving agricultural production technologies, we should also vigorously advocate the concept of energy conservation and emission reduction, and improve the efficiency of resource utilization.
- In 2006 and 2016, for the eleventh five-year plan in China and starting year "much starker choices-and graver consequences-in planning", clearly China's vision of the country's economic development has made the effective planning, green low carbon development has made some achievements, in response to the problem of global warming contribute force to be reckoned with.
- According to the elastic index decomposition of the driving factors of agricultural carbon emissions, we can find that in terms of improving energy use efficiency and agricultural technology, the excessive use and waste of energy can be reduced by promoting agricultural technology innovation and implementing relevant emission reduction policies. While improving energy efficiency, farmers' awareness of low carbon also plays a great role in the reduction of agricultural carbon emissions. Therefore, it is necessary to actively establish farmers' awareness of environmental protection and advocate green ecological agriculture.
- The innovation of this paper is that the driving effect of agricultural indirect energy consumption intensity on China's agricultural carbon emissions is stable, and the quantitative inhibiting effect on carbon emissions is strengthened year by year. In a practical sense, the development of China's agriculture has improved the energy efficiency to a certain extent. However, limited by energy-saving and emission reduction technologies, China's agricultural energy efficiency is becoming limited. It is increasingly difficult to achieve strong decoupling of agricultural energy consumption carbon emissions by reducing energy consumption intensity. In this case, to realize the decoupling of China's agricultural energy consumption carbon emissions, the key is to strengthen source governance and actively promote energy conservation and emission reduction in the agricultural sector, so as to directly



reduce agricultural energy consumption from the source and finally achieve the effect of reducing energy consumption carbon emissions.

**Acknowledgements.** This work was supported by National Social Science Fund (Grant No 15BJL057).

## References

1. Bai Juan.: Analysis of carbon emission decoupling effect and decoupling path in transportation industry [D] (in Chinese). Chang 'an university (2017).
2. China economic and social development statistical database, <http://tongji.cnki.net/kns55/index.aspx> , last accessed 2018/10/6.
3. Ding Hao, Dai Rufeng , Jiang Juanjuan.: Study on carbon emission decoupling effect of petrochemical industry in China [J] (in Chinese). Contemporary petroleum and petrochemicals,21(05):14-18 (2013).
4. Intergovernmental Panel on Climate Change (IPCC), 2007. IPCC Forth Assessment Report: Climate change 2007 (AR4). [www.ipcc.ch-publications\\_and\\_data-publications\\_and\\_data\\_reports.shtml](http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml), last accessed 2018/10/6
5. Liu Weibo.: Elastic decomposition analysis of decoupling of carbon emission from economic growth in Henan province [D] (in Chinese). Shaanxi Normal University (2013).
6. Tian Yun, Zhang Junbiao, Li Bo.: Study on China's agricultural carbon emissions: calculation, space-time comparison and decoupling effect [J] (in Chinese). Resources Science, 34(11):2097-2105.(2012)
7. Shi Changliang, Jie Changliang, Zhu Junfeng.: Analysis of the factors influencing decoupling of China's agricultural energy consumption [J] (in Chinese). Industrial Economic Review,7(04):116-126 (2016)
8. Zhang Yumei, Qiao Juan.: Analysis of decoupling between urban agriculture development and carbon emissions - Tapio elastic analysis based on decoupling theory [J] (in Chinese).On Economic Problems, (10):81-86 (2014)
9. Zhang Junbiao , Wu Xianrong.: China's provincial agricultural carbon emissions: the leading effect of growth and the decoupling effect of emission reduction [J] (in Chinese). Agricultural technical economy, (05):27-36 (2017)

# Multi-Criteria and Dynamic Braess's Paradox in Network Systems

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**Abstract.** Networking systems are becoming increasingly important in today's globalization conditions. Network systems show positive and negative effects and paradoxes. One of the paradoxes examined is Braess's paradox, which describes the situation when the addition of edges in the network can lead to a deterioration in the properties of the network system. The paper focuses on generalizing Braess's paradox. One way of generalizing is to consider multiple criteria. An example is analyzed when adding a zero-valued edge according to another criterion worsens the values of both criteria. The second way of exploration is the dynamism of Braess's paradox. Both of these generalizations lead to an even stronger versions of Braess's paradox than by the original problem.

**Keywords:** Networking System, Braess's Paradox, Multiple Criteria, Dynamism.

## 1 Introduction

Many of the current network systems are characterized by both the breadth and the complexity of network topology [2]. Overloading plays a growing role not only in transport networks but also in telecommunication networks. Complementarity becomes a decisive factor in information markets. Networks show positive effects. The product unit value increases with the expected number of units sold. Switching costs are also significant when switching to other services or switching to new technology. The decisions of the network users influence not only themselves, but also other participants in the size of profit and cost, timeliness of supply, environmental quality, etc. Paradox situations arise on the networks. Classical paradoxes include Braess's paradox. The paper focuses on generalizing it for multiple criteria and for its dynamic versions.

## 2 Braess's Paradox

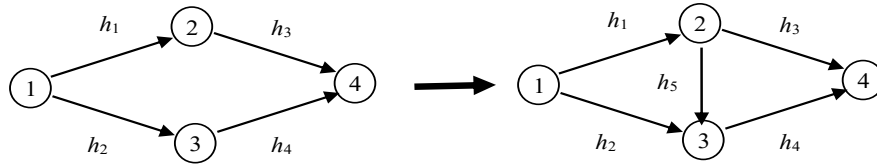
Behavior of network participants may be non-cooperative. An example may be the behavior of users of transport or telecommunication networks, where optimization from individual users does not lead to optimization of the whole system. This situation is

illustrated by the well-known Braess's paradox, when adding another connection by the same demand for service leads to an increase in costs for users [1].

We will analyze a concrete example. The original network in Fig. 1 is composed of four nodes 1, 2, 3, 4 and four edges  $h_1, h_2, h_3, h_4$ , the start and the end of the network consists of nodes 1 and 4. There are two paths between the start and end of the network  $C_1 = \{h_1, h_3\}$  and  $C_2 = \{h_2, h_4\}$ . Let's assume that the cost of individual edges depends on the size of the flows

$$n(h_1) = 10x_1, n(h_2) = x_2 + 50, n(h_3) = x_3 + 50, n(h_4) = 10x_4 \quad (1)$$

and the total required network flow  $X = 6$ .



**Fig. 1.** Braess's paradox.

In the case of optimization from a user's point of view, the equilibrium solution is given by the situation when all the paths between the start and end of the network have the same minimum costs and therefore users are not interested in changing flows on the path. The equilibrium solution is given by the flows on the edges

$$x_1^* = 3, x_2^* = 3, x_3^* = 3, x_4^* = 3 \quad (2)$$

and by the corresponding costs on the paths

$$n(C_1) = 83, n(C_2) = 83. \quad (3)$$

After changing the network by adding the edge  $h_5$  between nodes 2 and 3 with the cost  $n(h_5) = x_5 + 10$ , the next path  $C_3 = \{h_1, h_5, h_4\}$  will be created and the equilibrium solution in the original network will no longer be equilibrium in this situation. The equilibrium is defined by the same cost for all paths. In our example, the equilibrium solution will send a flow size of 2 units on each of the three paths, and hence the flows on individual edges

$$x_1^* = 4, x_2^* = 2, x_3^* = 2, x_4^* = 4, x_5^* = 2 \quad (4)$$

and the corresponding costs on the paths

$$n(C_1) = 92, n(C_2) = 92, n(C_3) = 92. \quad (5)$$

The cost has increased for each network user from 83 to 92. This increase is also due to the fact that the edges  $h_1$  and  $h_4$  are shared by two paths and increase the flow and cost. Braess's paradox is triggered by the network topology as well as the behavior of the participants, which is aimed at optimizing from an individual user perspective. If a path is added between the start and the end of the network that does not share the edges with the original link, then Braess's paradox does not occur.

### 3 Multi-Criteria Braess's Paradox

Multi-criteria formulation can also be considered. The role of costs can be extended, for example, to the consideration of emissions associated with edge flows. Adding a zero-emission edge leads to an increase in total emissions without changing the total flow [3].

Consider an example from the original network in Fig. 1, with the same assignment. Suppose, moreover, that the emissions at individual edges are dependent on the size of the flows

$$e(h_1) = 2x_1, e(h_2) = x_2, e(h_3) = x_3, e(h_4) = 2x_4. \quad (6)$$

For the total required network flow  $X = 6$ , the original equilibrium solution is given by the flows at the edges

$$x_1^* = 3, x_2^* = 3, x_3^* = 3, x_4^* = 3 \quad (7)$$

and total emissions are

$$E = 2(3) + 1(3) + 1(3) + 2(3) = 18. \quad (8)$$

After changing the network by adding the edge  $h_5$  between nodes 2 and 3 with zero emissions, the equilibrium solution will be given by edge flows

$$x_1^* = 4, x_2^* = 2, x_3^* = 2, x_4^* = 4, x_5^* = 2 \quad (9)$$

and total emissions will increase

$$E = 2(4) + 1(2) + 1(2) + 2(4) = 20. \quad (10)$$

Adding a new zero-emission edge will not only increase costs for all participants but also the amount of emissions generated.

Our example demonstrated that adding a zero-valued edge for another criterion may worsen values for both criteria. General consideration of multiple criteria and the search for equilibrium solutions with multiple criteria will be the subject of further research.

## 4 Dynamic Braess's Paradox

It is possible to consider the dynamic version of Braess's paradox [4]. We will proceed from the situation described in Fig. 1 after the change that occurred by adding the edge  $h_5$ . Now, however, the total flow  $X(t)$  will depend on time. In our example,

$$X(t) = t, t \in \langle 0, T \rangle \quad (11)$$

and there will be time-dependent flows at each edge

$$x_1(t), x_2(t), x_3(t), x_4(t), x_5(t) \quad (12)$$

with costs that are function of time-dependent flows

$$\begin{aligned} n(h_1) &= 10 x_1(t), n(h_2) = x_2(t) + 50, n(h_3) = x_3(t) + 50, \\ n(h_4) &= 10 x_4(t), n(h_5) = x_5(t) + 10, t \in \langle 0, T \rangle. \end{aligned} \quad (13)$$

Due to network topology and linear cost functions, this dynamic balance case is easy to solve. General cases can be solved using evolutionary variation inequalities.

There are 3 paths in the network  $C_1 = \{h_1, h_3\}$ ,  $C_2 = \{h_2, h_4\}$  and  $C_3 = \{h_1, h_5, h_4\}$ , 3 equilibrium solutions for the total flow  $t$ :

1. Only the path  $C_3$  with the flow size  $t$ . Flows at each edge

$$x_1(t) = t, x_2(t) = 0, x_3(t) = 0, x_4(t) = t, x_5(t) = t \quad (14)$$

with the cost of this path

$$n(C_3) = 21 t + 10. \quad (15)$$

2. Paths  $C_1$  and  $C_2$  with a flow of  $\frac{t}{2}$  on each path. There are flows at each edge

$$x_1(t) = \frac{t}{2}, x_2(t) = \frac{t}{2}, x_3(t) = \frac{t}{2}, x_4(t) = \frac{t}{2}, x_5(t) = 0 \quad (16)$$

with the cost of each path

$$n(C_1) = n(C_2) = \frac{11}{2} t + 50. \quad (17)$$

3. Paths  $C_1$  and  $C_2$  with the flow of size  $\frac{11}{13} t - \frac{40}{13}$  on each path and  $C_3$  path with the flow  $\frac{80}{13} - \frac{9}{13} t$ . Flows on individual edges

$$\begin{aligned} x_1(t) &= \frac{11}{13} t + \frac{40}{13}, x_2(t) = \frac{11}{13} t - \frac{40}{13}, x_3(t) = \frac{11}{13} t - \frac{40}{13}, \\ x_4(t) &= \frac{2}{13} t + \frac{40}{13}, x_5(t) = \frac{80}{13} - \frac{9}{13} t, \end{aligned} \quad (18)$$

with the cost of each path

$$n(C_1) = n(C_2) = n(C_3) = \frac{31}{13}t + \frac{1010}{13}. \quad (19)$$

By analyzing the dynamically expressed costs it is possible to divide the interval for the total flow  $t$  into three intervals:

1. For  $t \in \left[0, \frac{80}{31}\right]$  only path  $C_3$  is used, which uses the added new edge  $h_5$ .
2. For  $t \in \left(\frac{80}{31}, \frac{80}{9}\right]$  all three paths are used, including the new path  $C_3$ , and Braess's paradox is emerging.
3. For  $t \in \left(\frac{80}{9}, \infty\right)$  only old paths  $C_1$  and  $C_2$  are used and the added edge  $h_5$  is not used at all.

The dynamic version of the problem has shown an even stronger version of Braess's paradox, for some values of the dynamic total flow Braess's paradox is emerging and for some values of the dynamic total flow even a new path will never be used.

## 5 Conclusions

Many of the current economic systems have network connections. These network systems show various interesting effects and paradoxes. Braess's paradox shows an interesting situation that arises by adding another connection in the network system leads to an increase in costs for users by the same demand for service. The paper analyzes the multi-criteria and dynamic versions of Braess's paradox. Analyzed generalizations show even stronger versions of Braess's paradox. The results of the analysis have implications for the practical solution of problems in network systems. These generalizations will be a topic for further research.

**Acknowledgements.** This paper was supported by the Czech Science Foundation project No. P402/12/G097 DYME - Dynamic Models in Economics and by the grant No. IGA F4/57/2017, Faculty of Informatics and Statistics, University of Economics, Prague.

## References

1. Braess, D.: Über ein Paradoxon aus der Verkehrsplanung. Unternehmensforschung 12(2), 258–268 (1968). DOI: 10.1007/BF01918335.
2. Fiala, P.: Dynamické vytváření cen a alokace zdrojů v sítích. Professional Publishing, Praha (2016).
3. Nagurney, A., Dong, J.: Supernetworks: Decision-Making for the Information Age. 1st edn. Edward Elgar Publishers, Cheltenham (2002).
4. Nagurney, A.: Supply Chain Network Economics: Dynamics of Prices, Flows and Profits. 1st edn. Edward Elgar Publishers, Cheltenham (2006).

## Profitability Conditions of The Selected Companies from the Wig Food Industry Index in 2011-2018

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**Abstract.** The development of a financial situation of a given company, in other words accounting liquidity has a direct impact on the shape of the current situation of an enterprise and the future prospects. The economic theory has not clearly defined so far a group of indexes that may be used for an objective analysis of the financial situation of the studied enterprise. The accounting liquidity directly influences the level of the enterprise profitability. In spite of dependency and correlation between profit and liquidity of an enterprise the two phenomena should be divided to a certain extent as they occur in two different time periods. In the process of management an increase of a profit does not always result in possessing greater financial resources. The conducted studies clearly indicate the specific companies belonging to the WIG-Food index in the years 2011-2018, which were characterised by the highest level of profitability. At the same time the companies with a low level of profitability were selected in the research process. The following profitability indexes were used in the study: return on sales (ROS), return on equity (ROE) and return on assets (ROA). The main aim of the studies was to indicate the factors responsible for development of profitability of the selected companies, which in the years 2011-2018 belonged to the WIG-Food index using the basic Du Pont model.

**Keywords:** profitability, food industry, wig index companies.

### 1 Introduction

The accounting liquidity and profitability play one of the most important roles during a development of a financial situation of the enterprise at present and in the future. The most effective management of the enterprise clearly reflects its level of profitability [7]. In order to present the assessment of the enterprise and its ability in the management process, which aims at achieving profit from resources involved in conducting activity, we may use the profitability indexes, which are also defined as profitability indicators or rates of return. Unfortunately, in the economic theory a group of indexes that clearly and objectively present the financial situation of the enterprise have not been defined so far. While conducting the financial analysis of the enterprise there may be a problem due to a fact that the same value of the described index may be defined as a positive assessment for the enterprise while on the other hand it may generate negative

assessment. In order to present the described phenomenon we use the accounting liquidity index, if its level is high it may indicate a positive situation of the enterprise and contribute to discharging its current obligations and at the same time may confirm the accumulation of excessive amount of cash which will be non-profit asset item. The second similar example may be the fixed assets rotation coefficient, which indicates if the enterprise uses their assets effectively or cannot afford to purchase the sufficient amount of fixed assets due to the little amount of capital [2]. Additionally, during conducting the financial analysis of the enterprise there may be indexes indicating the good condition of the enterprise and a few other indexes which describe it as negative. Therefore, it may be difficult to assess clearly enterprise financial condition. A good solution to counteract the negative assessment of the enterprise financial condition is to use proper models and algorithms during the conducted studies, which allows to show the cause-and-effect relationships between the selected financial indexes that appropriately assess the correctness of the enterprise activity [13].

The term profitability may be defined as a surplus of the enterprise revenue on sales over the cost of revenues [12], whereas the profitability measure is a relation of profits obtained by the enterprise to invested capital or to achieved effects coming from used production factors [4]. The enterprise profitability is directly connected with its accounting liquidity, which is the enterprise ability to timely payment of liabilities [7]. This ability is determined by the amount of funds committed in the enterprise most liquid assets. The level of ability to settle the enterprise current liabilities depends on the amount of the enterprise liquid assets, for example cash [11]. A weak financial position of the enterprise may be caused by a lot of factors, e.g. the decreasing level of the enterprise financial liquidity, increase of financial liabilities due to contractors or the increased level of receivables difficult to collect [3]. One of the most important factors that have a direct impact on the enterprise accounting liquidity (and its financial capacity) is profit. The described category may reflect the possibilities of the enterprise development and is a base of assessment of the effectiveness during the management process [8]. In spite of the interrelations between profit and accounting liquidity the term should be divided due to the fact that they do not usually exist at the same time. The level of profitability, especially its growth, not always results in increase of cash inflow. At the same time the improvement of the enterprise profitability does not always mean the improvement of the enterprise situation (the level of cash). In the longer period a lack of payment capability of the enterprise may lead to its insolvency, so it is very important to analyse the accounting liquidity. It is perceived as a necessary prerequisite and when it is fulfilled may assure further proper functioning of the enterprise [10]. The level of profitability and accounting liquidity of the enterprise decide about its future. There are cases of enterprises that were profitable at the moment of bankruptcy (lack of accounting liquidity). Agriculture is a specific section of economy in which accounting liquidity of the enterprise (agricultural enterprise) does not always have a significant impact on its profitability. The accounting liquidity in this area of economy is typically at a high level [5]. According to Wasilewski [9] an increase of the level of the fastly growing accounting liquidity may affect the level of the agricultural enterprise efficiency in the process of using fixed assets and own capital. The relation between the level of the enterprise accounting liquidity and its profitability



has not been analysed adequately, which may justify a need to perform studies in this area.

## 2 The Aim and the Research Methodology

The main aim of the article is to present the factors responsible for developing profitability of the selected companies belonging to the WIG-Food index in the years 2011-2018 with the use of the basic Du Pont's model. As mentioned above, a basic measure that may be used for assessment of the financial condition of the enterprise is profitability index, including the return on equity ROE, which measures effectiveness of using a company's own capital. The proper high return on equity of the enterprise determines to a large extent its proper functioning and further development, which is largely of interest to the enterprise owners. The additional profitability indexes are return on assets and return on sales. Return on assets is a proportion of the enterprise net profit to the value of its assets. We can calculate it as a product of return on sales and asset turnover index. However, the return on sales is a profitability index that indicates how much net profit from sale remains in the enterprise. It is a proportion of net profit (see income statement) to net sales revenue.

Unfortunately, a synthetic approach to the return on equity do not allow to create wider interpreting possibilities of the obtained results (net income/own capital). It only allows to determine if the indicated profitability level is a result of low equity level or high net income [1]. The structural system called 'indexes pyramid' creates better interpretation possibilities and allows to present cause and result dependencies. It also enables:

- to present the directions allowing to achieve an aim determined by the suitable synthetic index,
- presents a place of individual index in the system and indirectly in the economic reality.

The Du Pont model is a well-known form of profitability index of the pyramid structure. The Du Pont model was created by Frank Donaldson Brown who was an employee in the 'Du Pont' company. Donaldson Brown was responsible for the improvement of the car company 'General Motors' finances after the part of its shares was overtaken by 'Du Pont' enterprise. The model was the first system enabling planning and control of the company activity and until 1970 won the name of predominant tool during the financial analysis [6]. The original equation looks as follows:

$$(Net\ income/sale \times sale/total\ asset = net\ income/total\ asset = ROA)$$

$$\frac{\text{zysk netto}}{\text{sprzedaż}} \times \frac{\text{sprzedaż}}{\text{aktywa ogółem}} = \frac{\text{zysk netto}}{\text{aktywa ogółem}} = ROA$$

The research population used for the studies were the companies belonging to the WIG-Food listed on the Warsaw Stock Exchange. The WIG-Food index belongs to the sector indexes and its companies also participate in the WIG index and at the same time are

qualified to 'food sector. The date of beginning of WIG-Food index is 31 December 1998 and the value of the index on this day amounted to 1279,56 points. The subindex WIG-Food Methodology is the same as WIG index, that is total return index. When it is calculated both prices of its shares and revenues from dividends and pre-emptive rights are taken into account.

### 3 The Current State and the Research Results

The financial results of the selected WIG-Food companies in the years 2011-2017 were characterised by a significant diversity (table 1). During these years only five of them achieved a positive net result. The biggest net income in the years 2011-2012 and 2017 had Wawel S.A., in the other years GK ZT Kruszwica S.A. In the eight other analysed companies in the years 2011-2017 at least in one year there was net loss (the most loss, that is during four years, had: Agroton Public Limited, Milkiland NV or GK Pamapol S.A.). Milkiland NV company is characterised by a especially negative tendency in developing financial result as since 2014 it has had every year loss (since 2015 there has been a decreasing tendency of the loss).

**Table 1.** The financial results of the selected WIG-Food companies in the years 2011-2017.

	2011	2012	2013	2014	2015	2016	2017
Agroton Public Limited	<b>-2119</b>	6760	<b>-5598</b>	<b>-80527</b>	<b>-9641</b>	21755	8299
GK Ambra S.A.	19143	16032	16531	26047	19017	17869	23073
GK Colian S.A.	19534	46427	27434	20791	66822	39689	<b>-30675</b>
KSG AGRO S.A.	27140	8108	<b>-31567</b>	<b>-50156</b>	<b>-2467</b>	1831	358
GK ZT Kruszwica S.A.	29971	3413	106706	119841	93235	107581	41276
Makarony Polskie S.A.	<b>-3347</b>	1170	2900	4143	4914	5092	5517
Milkiland NV	14391	12771	10835	<b>-71835</b>	<b>-72807</b>	<b>-38804</b>	<b>-7672</b>
GK ZPC Otmuchów S.A.	8663	6523	4825	9441	3467	<b>-36462</b>	<b>-2835</b>
Ovostar Union	19671	23456	30589	25339	30954	22153	22457
GK Pamapol S.A.	<b>-2654</b>	<b>-3296</b>	<b>-23753</b>	606	1071	3205	<b>-2351</b>
Pepes S.A.	8594	1895	654	3373	5288	17600	13364
Seko S.A.	<b>-4663</b>	2068	5274	4589	5021	4485	9007
Wawel S.A.	56783	66668	80467	88035	92868	85086	113322
<b>Negative financial result (bold)</b>							

In order to show the differences in the conditions of factors influencing the level of development of return on equity in the selected WIG-Food companies the basic Du Pont model was used at the first stage (table 2).

According to the data presented in table 2 the return on equity was significantly differentiated in the years 2011-2017. It resulted from the changes in the level of return on equity in the analysed period. The influence of the equity multiplier was definitely smaller.

The highest level of return on equity was observed in the Ovostar Union company (the average level of ROE amounted to 26,8%), except for 2014 when the value of the company KSG AGRO S.A. return on equity was 348,0% and 2016 when the ROE of the company Agroton Public Limited was 30,7%. The Wawel S.A. company also had high values of the return on equity in the years 2011-2017 (the values of the index ranged from 15,5% to 21,6%). The lowest ROE was observed in the Milkiland NV company.

The similar tendencies were in case of return on assets which is an arithmetic product of return on sales ROS and asset turnover index. The highest level of ROA was observed in the years 2012-2015 and in 2017 in the Ovostar Union company (the value of the index in these years ranged from 17,1% to 30,7%), in 2011 in the KSG AGRO S.A. company (ROA=22,3%), and in 2016 in the Agroton Public Limited company (ROA=26,6%). The biggest negative values of the returns on assets was in 2014 (for the Agroton Public Limited company ROA amounted to -82,2%, and for the KSG AGRO S.A. company ROA amounted to -54,8%). The high values of the return on assets as well as return on equity were observed in the Wawel S.A. company.

The return on equity multiplier in the years 2011-2017 remained in the majority of companies at the same level. The standard deviation level in 11 companies ranged from 0,1 to 0,5, with the exception of KSG Agro S.A. and Milkiland NV companies (in these entities the standard deviation amounted to 4,6 and 10,2). The highest leverage effect was observed in the Milkiland NV company in 2016 and 2017 (successively 29,0 and 13,7).

**Table 2.** Du Pont Analysis of the selected WIG-Food companies in the years 2011-2017.

	2011	2012	2013	2014	2015	2016	2017
Agroton Public Limited	-1.8% <sup>1</sup>	5.4%	-4.6%	-181.2%	-21.0%	30.7%	10.4%
GK Ambra S.A.	9.6%	7.8%	7.8%	11.5%	8.2%	7.4%	9.3%
GK Colian S.A.	3.2%	7.3%	4.1%	2.6%	7.8%	4.5%	-3.6%
KSG AGRO S.A.	37.9%	10.1%	-64.8%	348.0%	19.2%	-16.4%	-2.8%
GK ZT Kruszwica S.A.	4.6%	0.5%	14.5%	15.1%	11.2%	15.6%	6.1%
Makarony Polskie S.A.	5.6%	1.9%	4.6%	6.1%	6.9%	7.0%	7.3%
Milkiland NV	9.0%	7.4%	6.4%	-78.0%	-210.1%	-668.5%	-65.6%
GK ZPC Otmuchów S.A.	7.3%	5.2%	3.7%	6.8%	2.4%	-35.1%	-2.8%
Ovostar Union	24.2%	22.4%	22.6%	30.6%	40.7%	25.8%	21.6%
GK Pamapol S.A.	2.2%	-2.8%	-25.2%	0.6%	1.0%	2.9%	-2.2%
Pepees S.A.	9.5%	2.1%	0.7%	3.2%	4.8%	13.7%	9.5%
Seko S.A.	-10.3%	4.4%	10.2%	8.5%	8.8%	7.5%	15.5%
Wawel S.A.	21.6%	21.3%	21.6%	20.5%	18.9%	15.5%	18.0%

according to the formula: return on sales ROS\* asset turnover index\*equity multiplier  
= return on equity ROE

In the profitability assessment it is appropriate to indicate the correlation between the partial factors and the basic index. This analysis aims at controlling the degree of

influence of these factors on the basic index by determining their strength and direction. The differentiate method was used in the study. more precisely – three factors analysis on the ground of greater interpretation possibilities. Although this method has some drawbacks. including limited accuracy of measurement. it was admitted that its biggest benefit is general nature of the approach to the measurement of the analysis of the factors influencing the level of profitability.

The process of determining the influence of the analysed factors on the basic amount with the use of differentiate method is performed in a few stages. The final result aims at identifying the strength and direction of the impact of changes of the individual factors on the return on equity level. In order to calculate ROE. it is necessary to identify the impact of the change on the amount of deviation of the analysed phenomenon on the basis of the determined absolute deviation of the basic value.

According to the performed three factors analysis (table 3) in the years 2011-2017 in the selected WIG-Food companies the return on sales ROS changes significantly greater influenced on the ROE level than the other indexes (during these years in all analysed companies there were only five cases when the greatest influence had the asset turnover (in the companies: Wawel S.A. (twice). Makarony Polskie S.A.. Ovostar Union. Seko S.A.) and four cases when the greatest influence had the return on equity multiplier changes (in the companies: Milkiland NV (twice). KSG AGRO S.A.. GK Kruszwica S.A.). As regarding return on assets and equity multiplier in the significant majority a negative direction of strength was observed – in 44.9% possible cases (in case of return on sales – ROS - the negative direction was only observed in 6.4% possibilities).

**Table 3.** The strength of the impact of return on sales. assets turnover and the capital structure on return on equity on the basis of three factors analysis.

Agroton Public Limited						
	2012	2013	2014	2015	2016	2017
ROS na ROE	121.7	101.2	42.1	94.9	112.0	94.1
TAT na ROE	-20.4	-3.0	27.0	-0.8	6.9	5.7
ER na ROE	-1.2	1.8	30.9	5.9	-18.9	0.2

GH Ambra S.A.						
	2012	2013	2014	2015	2016	2017
ROS na ROE	104.5	1811.4	145.5	95.0	129.1	73.2
TAT na ROE	20.5	1584.8	-25.6	-17.3	-20.8	41.8
ER na ROE	-25.0	-3296.2	-19.9	22.4	-8.3	-15.1

GK Colian S.A.						
	2012	2013	2014	2015	2016	2017
ROS na ROE	113.0	124.7	85.5	112.0	101.0	97.4
TAT na ROE	9.7	8.0	-31.3	-3.2	-2.3	-1.5
ER na ROE	-22.7	-32.7	45.9	-8.8	1.3	4.0

KSG AGRO S.A.						
	2012	2013	2014	2015	2016	2017
ROS na ROE	102.3	55.3	-49.1	100.0	86.3	98.1
TAT na ROE	9.6	3.1	0.1	-1.6	11.6	-0.8
ER na ROE	-11.9	41.6	149.0	1.6	2.2	2.7
GK Kruszwica S.A.						
	2012	2013	2014	2015	2016	2017
ROS na ROE	102.3	120.0	558.1	69.2	35.0	105.2
TAT na ROE	-2.8	12.4	210.6	30.6	-9.3	-7.0
ER na ROE	0.4	-32.4	-668.7	0.2	74.3	1.8
Makarony Polskie S.A.						
	2012	2013	2014	2015	2016	2017
ROS na ROE	116.1	108.3	151.6	82.4	1212.8	-188.6
TAT na ROE	-12.7	6.1	-35.3	59.3	-931.5	225.1
ER na ROE	-3.3	-14.4	-16.3	-41.6	-181.3	63.5
Milkiland NV						
	2012	2013	2014	2015	2016	2017
ROS na ROE	74.8	201.9	66.5	31.6	-14.0	88.0
TAT na ROE	-16.1	-73.5	11.2	-13.7	-4.8	-0.1
ER na ROE	41.3	-28.3	22.3	82.1	118.8	12.1
GK ZPC Otmuchów S.A.						
	2012	2013	2014	2015	2016	2017
ROS na ROE	158.9	59.9	116.5	81.8	72.7	100.3
TAT na ROE	-64.2	12.7	3.2	15.0	11.0	-0.9
ER na ROE	5.3	27.4	-19.7	3.2	16.3	0.6
Ovostar Union						
	2012	2013	2014	2015	2016	2017
ROS na ROE	50.5	481.1	-14.2	65.4	78.6	120.0
TAT na ROE	49.9	-696.7	98.5	5.3	15.6	-28.9
ER na ROE	-0.4	315.7	15.7	29.2	5.9	8.9
GK Pamapol S.A.						
	2012	2013	2014	2015	2016	2017
ROS na ROE	122.8	118.6	100.3	107.5	91.6	96.0
TAT na ROE	-4.3	-4.0	-0.3	45.2	4.6	6.0
ER na ROE	-18.5	-14.6	0.0	-52.7	3.8	-2.0

Pepees S.A.						
	2012	2013	2014	2015	2016	2017
ROS na ROE	105.2	95.9	118.7	59.0	83.9	119.4
TAT na ROE	-5.3	2.1	-29.2	9.1	8.9	-16.5
ER na ROE	0.1	2.0	10.4	31.9	7.2	-2.9

Seko S.A.						
	2012	2013	2014	2015	2016	2017
ROS na ROE	97.2	112.9	87.3	22.7	119.8	82.1
TAT na ROE	4.4	-13.3	-5.7	151.3	14.4	42.9
ER na ROE	-1.5	0.4	18.3	-74.0	-34.2	-25.0

Wawel S.A.						
	2012	2013	2014	2015	2016	2017
ROS na ROE	13.7	88.4	-187.3	8.8	57.6	241.2
TAT na ROE	-241.5	-39.3	202.0	89.6	17.2	-103.2
ER na ROE	209.8	-245.1	85.4	1.5	25.1	-38.0

## 4 Conclusion

The conducted studies have proved that the basic operational activity and the achieved sales revenues are significantly important for the analyzed WIG-Food companies. The return on sales (ROS) has a decisive influence on the development of the return on equity level. The equity multiplier plays a relatively insignificant role, so it may be concluded that the leverage effect is of a marginal importance. On the basis of the conducted studies with the use of the three factors analysis, it may be concluded that in the years 2011-2017 the selected WIG Food companies [ROE level] were dependent, to a significant degree, on the changes taking place at the sales profitability (ROS) level in relation to the other factors. In the years 2011-2017 the level of equity return of the analysed companies was characterised by the large variation, which may influence on the proper functioning of the companies. The variations of the asset profitability level in the analysed time period were responsible for this state of affairs. The impact of the equity multiplier was definitely smaller than the direct influence of the variation of the asset profitability level. A very good example of the company with the high level of equity profitability in the years 2011-2017 was the Ovostar Union company. The high level of the return on equity ratio in the analysed period was also noticed in the Wawel S.A. company. The WIG food companies should be characterised by the proper management and transparency of their activities in order to provide the high profitability level, which directly influences on the possibility of keeping their position on the market and belonging to the index.

## References

1. Bednarski, L., Borowiecki, R., Duraj, J., Kurtys, E., Waśniewski, T., Wersty B.: Analiza ekonomiczna przedsiębiorstwa. Wydawnictwo AE im. O. Langego. Wrocław. p. 85–90 (2001).
2. Brigham, E.F.: Podstawy zarządzania finansami. PWE. Warszawa. p. 66–85. (1996).
3. Gołębiewski, G., Tłaczała, A.: Analiza ekonomiczno-finansowa w ujęciu praktycznym. Difin. Warszawa. p. 157 (2005).
4. Kaczmarek, T.: Zarządzanie płynnością finansów małych i średnich przedsiębiorstw – ujęcie praktyczne. Difin. Warszawa. p. 112 (2007).
5. Kisielińska, J.: Wykorzystanie metod wielowymiarowej analizy do oceny sytuacji finansowej gospodarstw rolniczych. Wieś i Rolnictwo. nr 4 (121). p. 83-95 (2003).
6. Really modified Du Pont analysis: five ways to improve return on equity. [www.sbaer.uca.edu/research/sbida/2002/19pdf](http://www.sbaer.uca.edu/research/sbida/2002/19pdf). last accessed 2018/10/04.
7. Sierpińska, M., Jachna, T.: Ocena przedsiębiorstwa według standardów światowych. Wydawnictwo Naukowe PWN. Warszawa. p. 195 (2004).
8. Wasilewski, M.: Płynność finansowa a efektywność gospodarstw indywidualnych. Roczniki Nauk Rolniczych. Seria G – Ekonomika Rolnictwa. t. 92. z. 1. p. 231 (2005).
9. Wasilewski, M.: Poziom wskaźnik szybkiej płynności finansowej a efektywność przedsiębiorstw rolniczych. In: Zarządzanie finansami firm – teoria i praktyka. Prace Naukowe AE we Wrocławiu. Wrocław. nr 1159. p. 450 (2007).
10. Waśniewski, T., Skoczylas, W.: Analiza przepływów środków pieniężnych – pomocą w zarządzaniu finansami przedsiębiorstwa. Rachunkowość. nr 6. p. 271. (1996).
11. Wawryszuk-Misztal, A.: Strategie zarządzania kapitałem obrotowym netto w przedsiębiorstwach – studium empiryczno-teoretyczne. Wydawnictwo UMCS. Lublin. p. 83 (2007).
12. Wskaźnik rentowności. [https://mfiles.pl/pl/index.php/Wska%C5%BAAnik\\_rentowno%C5%9Bci](https://mfiles.pl/pl/index.php/Wska%C5%BAAnik_rentowno%C5%9Bci). last accessed 2018/10/04.
13. Żwirbla, A.: Analiza według modelu Du Pont – zastosowanie praktyczne. Rachunkowość. 1/2006. p. 10 (2006).

## Structural Transformations of Agriculture in Poland in the Years 2006-2016

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**Abstract.** The article presents the changes in the productivity and effectiveness structure of Polish agriculture in the years 2006-2016 and the consequences and reasons of these transformations. The main aim of the study is to identify the most important changes in the agricultural production with an indication of their potential consequences. The data relating to the selected results in the agricultural sector at the voivodeship level was used in the study. It is stated that during the analysed period significant transformations of economic structure took place in the agricultural sector in Poland. The consequence of the conducted policy was a limitation of share of small farm holdings in the general structure. A significant increase of investment outlays also took place, which facilitated the growth of the agricultural production effectiveness. It is worth noting that in Poland, despite to the global trend of reducing expenditures on agriculture sector, recorded a stable economic situation of agriculture. The calculations were performed with the use of the comparative analysis, the trend analysis and the Ward's method.

**Keywords:** Agriculture, Structure, CAP (the Common Agricultural Policy).

### 1 Introduction

The issue of structural transformations in agriculture is frequently dealt with both in domestic and foreign literature. The reason of such kind of studies is the fact that the structural transformations are still present in the rural areas, which is especially visible in agriculture as well as in the agri-business sector. Each activity of agricultural producers results in a change of resources allocation and is usually caused by the accepted strategy due to the conducted policy and influence of the market mechanisms. The transformations are supported by social and economic development, which is a consequence of the shift of economic forces between the countries. This phenomenon is defined as a process of structural adjustments. According to Eichengreen [6] the global structural transformations take place in line with 'the waves rule', in which an economic change taking place in a given country with time moves to other countries. The change assimilation by other regions results from the evolution of economic conditions, including: population migration, technological progress, labour costs changes or discovery of new natural resources [25]. Additionally, a term of radical



innovations was presented [28], which are able to introduce to economic life innovation waves modifying the character of economic life.

Although the studies on the nature of structural transformations in economy are often conducted on the basis of the industry and services sector analysis (as the sectors of potentially high level of profitability), the phenomenon of structural transformations and the presence of waves of changes is also observed in the agricultural sector. Considering the issue theoretically, the key aspect, influenced by market structures, is prosperity resulting from connected with it effectiveness [8]. The increase of performance in this sector may be based, among other things, on the improvement of the employment structure or diversification of cultivation and breeding in the individual regions, which may be a classic example of structural transformations. It should be emphasized that the growing importance for the agriculture development have information and knowledge which are elementary resource fostering a thriving of the functioning in modern way civil societies, their economies and regions [9].

## **2 The aim and Methods of the Study**

The aim of the study was to present transformations in the productivity and effectiveness structure of agriculture in Poland in the years 2006-2016 and trends of agriculture development in the individual regions. As the reason of implementing structural transformations an accession of Poland into the European Union was considered and the possibilities in the area of using the tools of the Common Agricultural Policy. During the pre-accession period Poland used pre-accession programmes, such as SAPARD, PHARE, however, after joining the European Union entrepreneurs have had the chance to use the following: the preferential credits, export subsidies, direct payments, private storage subsidies, reference prices and others [7]. The annual results were analyzed in the studies and they were chosen due to the availability of data. The comparative analysis, trend analysis and the Ward method were used to assess the concentration of features in the individual regions.

## **3 Structural Transformations in the Polish Agriculture in Total and their Reasons in Poland**

The Polish agriculture underwent a fundamental transformation in the 1990s that was a consequence of the social and economic changes in the Central and Eastern Europe. The second stage of evolution took place with the accession of Poland to the European Union in 2004 due to the possibility to use the tools of the Common Agricultural Policy. They had a significant impact on the transformations in many postcommunist countries and it was especially visible in relation to organisation and economic performance of farm holdings [29].

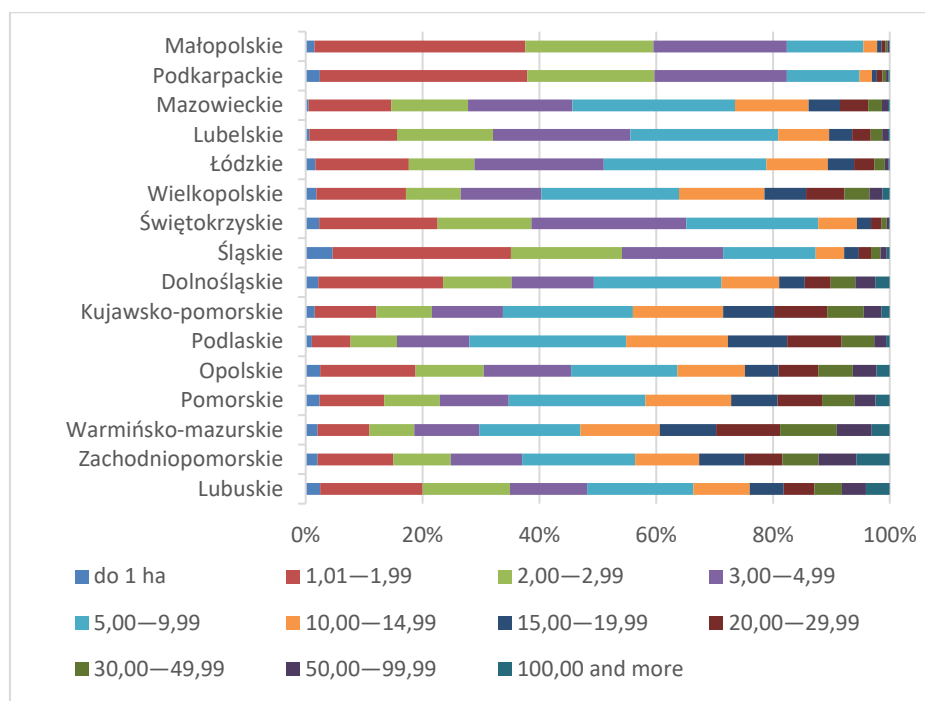
The structural transformations in the economy may be considered as a result of economic growth or as its cause [27]. In case of agriculture the most frequently is considered the analysis of consequences and reasons of structural transformation of this

sector through the prism of changes regarding its effectiveness and productivity. As recent analyses show [11, 23] the question is posed whether (or alternatively, at what scale) segregated land for nature should be separated from land for production (land sparing), or integrated with production and conservation on the same land (land sharing or wildlife-friendly farming). Moreover, study shows that it is needed to notice that many wild species cannot survive in even the most wildlife-friendly farming systems, protection of wild land is essential what also should be taken in economic analyses [17, 23]. What is more, the structural transformations may be discussed from a few perspectives: changes of the size of farm holdings, transformations of distribution of production factors, institutional links or financial conditions [2]. According to the classification proposed by Zegar the following structures may be included: agricultural, economic, scale, market, ecological, social and economic, spatial and the structure of type of farm holdings [30].

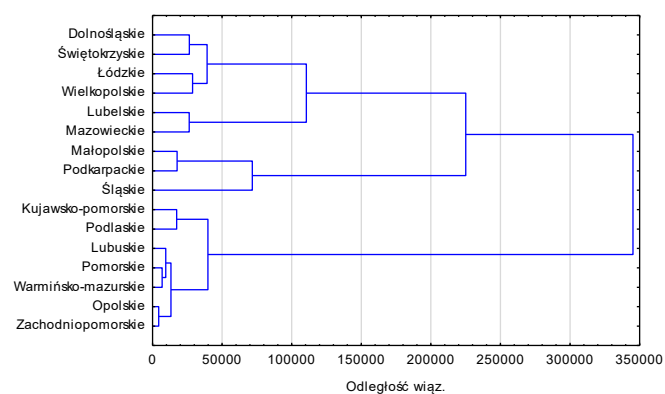
The tools used in the Common Agricultural Policy may stimulate the introduction of the transformations in the structure of agriculture, assuming that the support dedicated for the farmers will be based on the prior analyses of the pre-existing structure of agricultural production and recommendations resulting from it [3]. The appropriate focus of the support based on the current assessment of the changes in agriculture is essential.

#### **4 Structural Transformations in Agriculture in Poland**

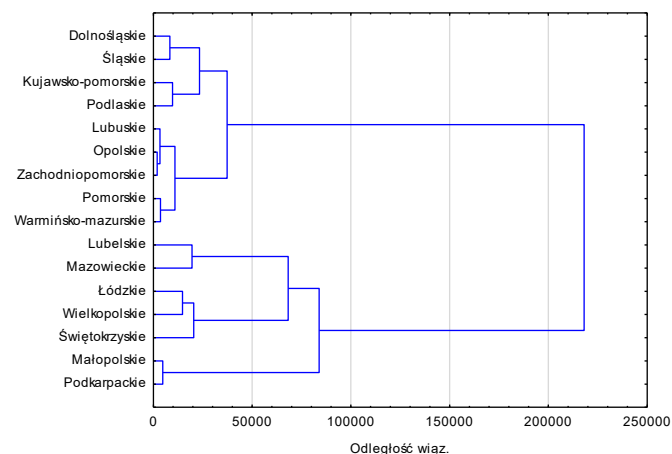
Poland has agricultural area resources that compared to the other European countries may be considered as significant. Similar resources to Poland in terms of area have the following European Union countries: Great Britain, Germany, Romania and Italy, larger only France and Spain [5]. Analysing the structure of the agricultural areas of the other countries it may be emphasized that it contains mainly of big and very big farm holdings – in accordance with the statistical data the farm holdings with over 50-hectare account to 34.2% in Denmark, 28.4% in Germany and 29.9% in the Czech Republic and 12.2% in Slovakia [24]. The politics that lead to the present state of affairs was different in the regions (in Germany it was diversification policy aiming at building the structure based on coexistence of big farm holdings and sell family farm holdings [4]) and additionally it covered long periods (in Denmark development to the current structure lasted over one hundred years [22]).



**Fig. 1.** Farm holdings according to the area groups in 2016 [26].

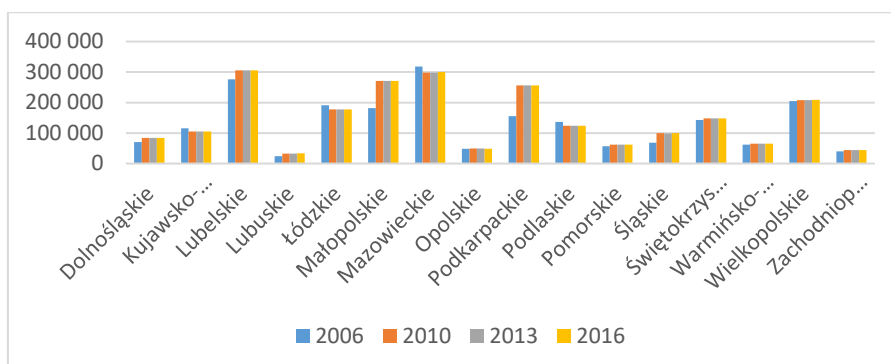


**Fig. 2.** Similarities between voivodeships in terms of the area structure of farm holdings in 2006 [26].



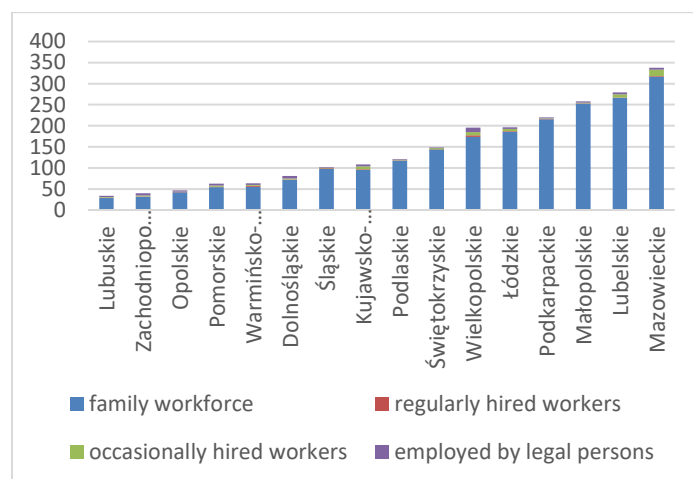
**Fig 3.** Similarities between voivodeships in terms of the area structure of farm holdings in 2016 [26].

One of the main aims of the Polish agriculture is to increase an average area of the farm households [14]. Similarly, to the great majority of UK farms, Polish farms are run as family businesses, the family dimension of these businesses is frequently neglected. There are nevertheless important inferences to be drawn from studying the farm family, its forms and functions, and the way that the family and the business interact [10]. The agricultural transformations in Poland taking place recently have far-reaching social and economic consequences that require taking into account such phenomena as specialisation, concentration and intensification of production. The agricultural policy in our country needs an evolutionary model of structural transformations of individual farm holdings [34]. During the analysed period the significant transformations of the area structure of agriculture in Poland took place, as presented in figures 1-3. Podkarpackie and Małopolska voivodeships are characterised by the biggest fragmentation and farm holdings below three hectares constitute over half of the agriculture structure in these regions. The largest increase in the number of farm holdings with the area over 50 hectares during the analysed period was in the following voivodeships: Wielkopolska, Masovian and Lublin. In addition, the progressing process of polarisation into two groups of voivodeships with different features in relation to the farmland area may be noticed (fig. 2 and 3).

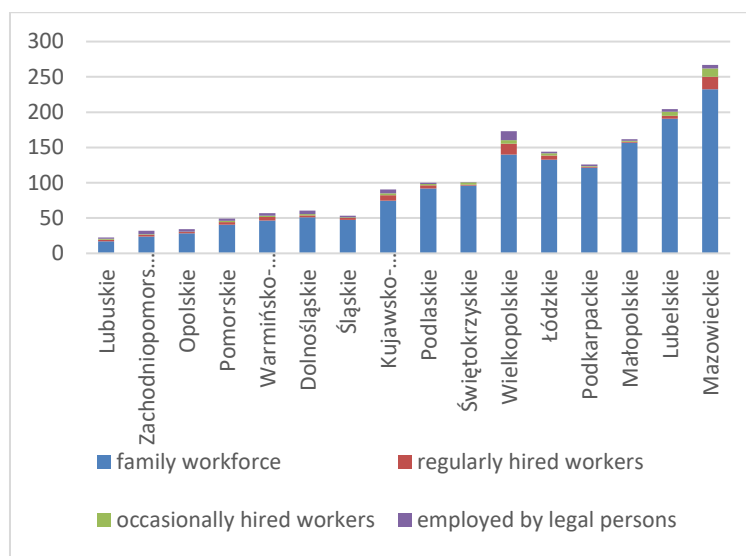


**Fig. 4.** Working in agriculture according to voivodeships [26].

The important consequence of the accession of Poland to the European Union was the transformation at the level of employment in the individual sectors. This phenomenon was visible in relation to the rapid increase of the number of employed in the service sector with the structural loss (percentage decrease of the share of employed in the given sector in relation to the whole country economy) for other sectors, especially agriculture [10]. In spite of the ongoing transformations in terms of value the agriculture sector has not recorded significant decline in the employment, and on the contrary in the selected voivodeships such as Małopolska or Lublin a significant growth of employment in this sector was recorded (fig. 4).

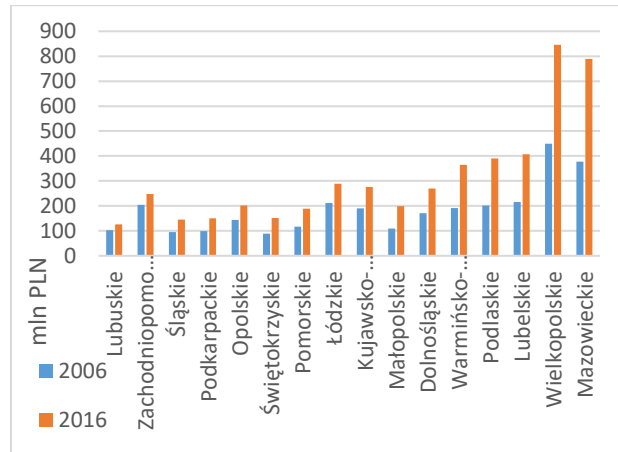


**Fig. 5.** The labour input in farm holdings in 2006 [26].

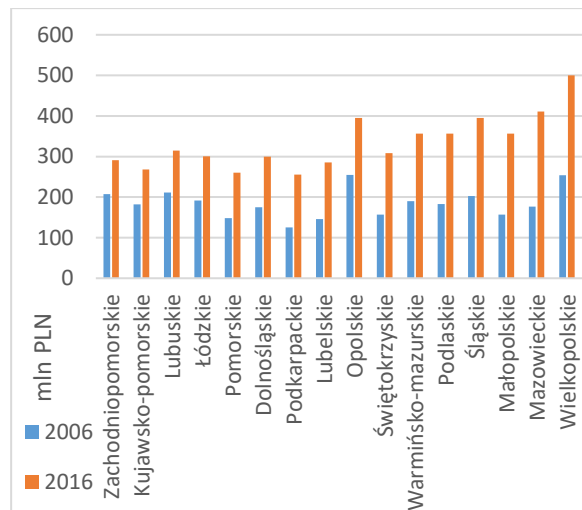


**Fig. 6.** The labour input in farm holdings in 2016 [26].

The high number of people employed in agriculture proved to be an essential factor limiting the growth of agricultural production effectiveness in Poland [16]. As a consequence, there has been a reduction of agriculture modernisation and lower productivity of the sector in the country [1]. The process of limitation of employment stimulates the changes of rural areas modernisation [30]. Additionally, the shift of workforce from agriculture to non-agricultural activities supports the improvement of not only farmers income but also other inhabitants of rural areas [13]. As presented in figures 5-6 during the analysed period in Poland there was a significant drop of labour input in agricultural sector. These changes were especially visible in the voivodeships with the high level of labour input in the sector, including Podkarpackie and Małopolska voivodships that were characterised by, indicated earlier, high farm holdings fragmentation. Moreover, the increase of employment of employed persons in Wielkopolska and Małopolska regions may be observed.



**Fig. 7.** Investment outlays in agriculture and hunting for 1 ha agricultural area in PLN [26].



**Fig. 8.** Investment outlays in agriculture and hunting for 1 ha agricultural area in PLN [26].

The elimination of restrictions on trade, including agricultural products, which took place in Europe and Poland after 2004, resulted in increased competition between entities on the scale of the entire region. Meeting global competition requires an increase in the scale and quality of products, which in turn requires the modernization of the machinery park of farms and an increase in investment outlays for this purpose. In addition, the agricultural sector is stimulated to change in the modes of production and management itself, which entails the necessary training costs. These changes should enable farmers to adapt to the evolving agricultural market in Europe, as well as the ability to reduce the number of employees, and thus reduce the costs of their

operations. Finally, the transformations of the structure of labor and capital expenditures should contribute to the separation of a group of specialists dealing with agriculture in Poland. As shown in Figures 7-8, expenditures in the sector in all voivodships during the period under examination increased significantly. In total, the differences between voivodships are significant and point to the distinctive feature of Mazowieckie and Wielopole voivodships, as regions with the highest increase in total investment. In the case of spending on one hectare, the situation seems to be leveled across Poland and indicates an increase in investment outlays in the country.

**Table 1.** Changes of purchasing agricultural products for 1 hectare in the years 2006-2016 in Poland (counted year/year in kg/ha, 1t/ha) [26].

Transformation Year/Year	2010 /2006	2016 /2010	2010 /2006	2016 /2010	2010 /2006	2016 /2010	2010 /2006	2016 /2010	2010 /2006	2016 /2010	2010 /2006	2016 /2010
Voivodship	Basic cereals		Potatoes		Slaughter Livestock		Cattle		Pigs		Milk	
Dolnośląskie	39%	31%	26%	25%	1%	4%	17%	-2%	-24%	-53%	-5%	9%
Kujawsko-pomorskie	18%	26%	8%	93%	-2%	53%	-37%	118%	-11%	44%	5%	23%
Lubelskie	1%	39%	29%	44%	10%	14%	11%	-6%	-12%	6%	-8%	4%
Lubuskie	47%	50%	50%	489%	22%	40%	2%	27%	1%	12%	15%	-7%
Łódzkie	38%	-4%	7%	145%	-5%	48%	-17%	82%	-15%	39%	11%	13%
Małopolskie	-13%	129%	85%	29%	-2%	-5%	7%	-45%	-8%	-7%	7%	4%
Mazowieckie	61%	25%	-3%	4%	24%	80%	11%	53%	-8%	3%	14%	32%
Opolskie	67%	46%	-6%	20%	44%	-7%	5%	-14%	40%	-19%	15%	15%
Podkarpackie	41%	61%	92%	178%	20%	7%	-10%	-24%	11%	7%	4%	16%
Podlaskie	0%	33%	-6%	146%	13%	30%	55%	-2%	-18%	-3%	14%	27%
Pomorskie	17%	49%	58%	13%	154%	74%	282%	23%	85%	77%	11%	42%
Śląskie	29%	49%	100%	500%	47%	15%	47%	4%	-6%	-2%	19%	31%
Świętokrzyskie	118%	75%	250%	86%	35%	46%	29%	62%	11%	26%	1%	14%
Warmińsko-mazurskie	6%	-15%	-18%	78%	19%	26%	5%	39%	0%	19%	15%	20%
Wielkopolskie	89%	14%	7%	124%	0%	41%	6%	69%	-9%	20%	13%	39%
Zachodnio pomorskie	56%	38%	59%	46%	26%	15%	-47%	-20%	8%	-27%	1%	5%

The transformations of the structure of agricultural sector may be clearly observed on the basis of transformations of agricultural production. Although there is a distinctive variety in production between voivodeships (resulting from, among others, different quality of soils and other natural factors [19]) a common tendency of the effectiveness improvement in various types of production in the whole country may be noticed. The cultivations, especially potato-growing, is characterised by the largest increase of productivity. In the whole country this growth began from the average level of 62 kg/ha



in 2006 to the level of 129 kg/ha in 2016. The biggest changes were recorded in Silesia, Świętokrzyskie and Lubuskie. In case of animal production, the significant characteristics in the production of pigs for the Polish agricultural market may be observed. The values for this farming were systematically limited in the majority of voivodeships in the whole country. The only exception is Pomorskie voivodeship where this value increased from the level of 107 kg/ha in 2006 to 349 kg/ha in 2016, therefore the national averages for these years were successively 137 kg/ha and 159 kg/ha, showing a progressing trend. The direction of reducing pork production in Poland results from mitigation of phenomena of pig cycles [21] through the import of meat from the other European Union countries. In case of the remaining farming, as well as cows' milk production, the increase was recorded, which also resulted (by relocation of production resources) in the reduction of pork production.

## 5 Conclusion

The aim of the study was an attempt to capture the structural transformations in agriculture that accompany a long term economic growth. The attempt to describe and explain the selected phenomena in this area of production in Poland was undertaken. In the presented analysis a specific perspective was adopted in which the development is perceived as a resultant of the production factors efficiency measured by the effectiveness of the sector. On such a basis the considerations concerning transformations of factors structure (capital and work) as well as the effects of production in agriculture were undertaken.

During the analysed period 2006-2016 in Poland significant transformations of economic structure in agricultural sector took place resulting mainly from accession of Poland to the European Union as well as the Common Agricultural Policy.

The most important consequences of the policy implemented in this period included a decrease of participation of small farm holdings in the general structure, which was a result of the progressing sector consolidation as an answer for the the agricultural policy. Even though this evolution contributed to the reduction of the labour input in the sector it did not influence on the reduction of the number of agricultural employees.

During the analysed period there was a significant increase of investment outlays in all analysed areas, which supported the increase of agricultural production effectiveness, especially potatoes. In farming a change of structure in terms of relocation of production resources from beef farming to other animals farming was noticed.

## References

1. Baer-Nawrocka, A., Poczta, W.: *Przemiany w rolnictwie*. In: Nurzyńska I., Poczta W. (eds.) *Polska wieś 2014. Raport o stanie wsi*, Wydawnictwo Naukowe SCHOLAR, pp. 92, Warszawa (2014)
2. Boehlje, M.: *Structural change in the agricultural industries: How do we measure, analyze and understand them?*, *American Journal of Agricultural Economics*, pp. 1028-1041, (1999)

3. Czyżewski, A.: Wydajność pracy jako przesłanka restrukturyzacji zatrudnienia w rolnictwie, ZN SGGW Problemy Rolnictwa Światowego, 2017, t. 17, s. 41.
4. Dacko, M., Dacko, A.: Dylematy zrównoważonego rozwoju polskiego rolnictwa, Zeszyty Naukowe SERIA, t. XIII, z. 8, pp. 33–38, (2011)
5. Dacko, M., Dacko, A.: Poprawa struktury obszarowej polskiego rolnictwa – podejście systemowe, Problemy drobnych gospodarstw rolnych, nr 2, pp. 23-37, (2014)
6. Eichengreen, B.: Global Shifts, referat w ramach Bank of Finland's 200<sup>th</sup> Anniversary, Helsinki,
7. Firlej, K. Ciura, K.: Public support in the food industry in Poland, Publisher: University of Hradec Kralove, Editors: University of Hradec Kralove 2016, pp. 200-210.
8. Firlej, K., Hamulczuk, M. et al. (eds.): Struktury rynku i kierunki ich zmian w łańcuchu marketingowym żywności w Polsce i na świecie, Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej – Państwowy Instytut Badawczy, pp. 7., Warsaw 2015
9. Firlej, K., Żmija, D.: The specificity of knowledge management in the food industry in Poland, *Ekonomie a Management* 20(1): 83-97, (2017)
10. Gasson, R.: The farm as a family business: a review. *Journal of agricultural economics*, (1988).
11. Green, R.E., Cornell, S.J., Scharlemann, J.P.W., Balmford, A.: Farming and the fate of wild nature. *Science*, 307 (2005), pp. 550-555
12. Gwiazdzińska-Goraj, M., Jezierska-Thöle, A.: Zmiany w strukturze pracujących i bezrobocia na obszarach wiejskich polski północnej i zachodniej oraz Niemiec wschodnich, *Acta Universitatis Lodzianensis*, pp. 116-132, (2013)
13. Kaleta, A.: Wielozaawodowość na obszarach wiejskich – perspektywa globalizacji. In: *Polska wieś 2025*, Wilkin J. (eds.), Fundusz Współpracy, pp. 11, Warsaw (2005)
14. Kałuża, H.: Wybrane problemy rozwoju małych gospodarstw rolnych w opinii ich właścicieli, *Zeszyty Naukowe SGGW w Warszawie – Problemy Rolnictwa Światowego*, t. 9(24), pp. 58-64, (2009)
15. Karwat-Woźniak, B.: Gospodarstwa wysokotowarowe w rolnictwie chłopskim. Synteza wyników badań 2005-2009, IERiGŻ-PIB, Warszawa, pp. 41, (2009)
16. Karwat-Woźniak, B.: Zasoby pracy w polskim rolnictwie indywidualnym i ich wykorzystanie, *Roczniki Naukowe Ekonomii Rolnictwa i Rozwoju Obszarów Wiejskich*, T. 102, Z. 1., pp. 70-71, (2015)
17. Klein, A.-M., Vaissière, B.E., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A.: Importance of pollinators in changing landscapes for world crops, *Proc. Roy. Soc. Lond. B*, 274 (2007), pp. 303-313
18. Kowalski, A., Rembisz, W.: Rynek rolny i interwencjonizm a efektywność i sprawiedliwość społeczna, IERiGŻ-PIB, , s. 42-45, Warsaw (2005),
19. Krasowicz, S., Igras, J.: Regionalne zróżnicowanie wykorzystania potencjału rolnictwa w Polsce. *Pamiętnik Puławski* nr 132, pp. 233-251, (2003)
20. Kulawik, J.: Efektywność a konkurencyjność. In: Kulawik J., Józwiak W. (eds.): *Analiza efektywności gospodarowania i funkcjonowania przedsiębiorstw rolnych powstałych na bazie majątku byłych PGR*, IERiGŻ-PIB, Warszawa, pp. 27-31., pp. 27-31, Warsaw (2005)
21. Mierzejewski, M., Lampart, M.: Analysis of Business Cycles in the Breeding of Pigs, Cattle and Poultry and their Relationship to the Causality of Wheat and Rye Cultivation in Poland, *Zeszyty Naukowe SGGW Problemy Rolnictwa Światowego*, vol. 18, nr. 2., pp. 218 – 227.
22. Musiał ,W., Otoliński, E.: Rozważania nad potrzebą przemian gospodarstw rolniczych w regionach rozdrobnionych agrarnie, *Roczniki Nauk Rolniczych*, ser. G, t. 96, z. 4, pp. 147–154, (2009)

23. Phalan, B., Balmford, A., Green, R.E., Scharlemann, J.P.W.; Minimising harm to biodiversity of producing more food globally. *Food Policy*, 36 (2011), pp. S62-S71
24. Poczta W. (eds.): *Gospodarstwa rolne w Polsce na tle gospodarstw Unii Europejskiej – wpływ WPR.*, Główny Urząd Statystyczny, p. 7., Warsaw (2013)
25. Rodrik, D.: The Past, Present, and Future of Economic Growth, in: Allen F.: *Towards a Better Global Economy. Policy Implication for Citizens Worldwide in the 21<sup>st</sup> Century*, Oxford University Press, Oxford.
26. Polish Central Statistical Office (GUS), <http://stat.gov.pl/>, downloaded: 23.08.2018.)
27. Schmitt, G.: Is Structural Change Really a Source of Economic Growth?, *The Case of Agriculture. Journal of Institutional and Theoretical Economics*, pp. 470-499, (1990),
28. Schumpeter, J.: *The Theory of Economic Development*, Harvard University Press, Cambridge, Mass.
29. Štřeleček, F.: Comparison of subsidies in the Visegrad Group. *Roczniki Naukowe Ekonomii Rolnictwa i Rozwoju Obszarów Wiejskich*, t. 100, pp. 91-102, (2009)
30. Tomczak, F., *Gospodarka rodzinna w rolnictwie. Uwarunkowania i mechanizmy rozwoju*, IRWiR-PAN, pp. 204, Warsaw (2005)
31. Woś, A.: *Rolnictwo polskie 1945-2000. Porównawcza analiza systemowa*, IERiGŻ, pp. 56-59, Warsaw (2000)
32. Zegar, J.: *Dochody w rolnictwie w okresie transformacji i integracji europejskiej*, IERiGŻ-PIB, pp. 73-74, Warsaw (2008)
33. Zegar, J.: *Struktura obszarowa indywidualnych gospodarstw rolnych w Polsce. Stan i perspektywa zmian. Realia i Co Dalej*, nr 3(24), pp. 31–56, (2011)
34. Zegar, J.: *Struktura polskiego rolnictwa rodzinnego pod koniec pierwszej dekady XXI wieku*. Wydawnictwo Warszawa: IERiGŻ-PIB, pp. 7-16, (2009)

## Development of the Venture Capital Market against the Selected World Competitors

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**Abstract.** The article deals with the issues of venture capital market development. The determinants of functioning and growth of the venture capital market were discussed. On the basis of the data concerning venture capital investments as % of GDP and availability of financing from the venture capital funds the development of the market in the European Union and selected world countries in the years 2012 and 2016 is presented. The results of author's research are presented with the use of Warda methods concerning the grouping of the member countries and selected world countries due to the similarities of venture capital market. As a result of the conducted cluster analysis four group of countries were selected. In the first group (A) are the countries with the highest financial availability of venture capital and the biggest share of venture capital in GDP. The second group (B) includes the countries with a slightly lower financial availability of venture capital and the share of venture capital in GDP lower than in group A countries. The third group (C) contains the countries with the lowest financial availability of venture capital and the lowest share of venture capital in GDP. The fourth group (D) includes the countries where venture capital markets are better developed than in group C countries and at the same time worse than in group A and B countries.

**Key words.** Venture Capital, Investment Financing, Innovation.

### 1 Introduction

The issues of financing new, original and not verified on the market yet ideas of all the innovators with the development of technology always is accompanied by difficulties due to high risk of enterprises failure and the loss of paid capital funds. A person who had an idea but did not have the capital was forced to search for external financing among private people or banks that were interested in their innovative projects. On the other hand, a kind of bond has always functioned on the line innovator – capital donor. First of all, the innovator in order to implement their project tried to convince private people or a bank to participate in the enterprise and as a consequence to gain financial benefits. Secondly, among the capital donors always functioned a group of investors who were not satisfied with the profit coming from traditional investment of free funds. In return for the possibility of receiving in the future over average rate of return they were willing to take risk. An enhancement

of cooperation between innovators and investors was a guarantee of a dynamic development of science and technology. The funding structure of innovative projects presented above resembles to an extent a contemporary financial instrument which is a venture capital [15].

In the literature on the subject exist a lot of interpretations of the term venture capital. In the P.A. Samuelson's synthetic definition, the venture capital is an investment funds made available for implementation of high risk projects [13]. On the other hand, in the wider approach of P. Drobny the venture capital is a form of share-related financing. It exists outside the capital market and therefore it is intended for small and average enterprises which are not listed on the stock market. The investment involves purchasing shares of the given enterprise by the external investor who is going to sell them in the future. The venture capital investor is not usually interested in the contemporary management of the enterprise and the period of their investment lasts from two to five years. In most cases it is a minority shareholder although there are also cases of majority shareholders [3].

The issue of impact of venture capital funds activity on innovations generating has been dealt by various researchers so far. International publications on the subject include among others Gompers and Lerner [7] or Dessi and Yin [2] who considered both positive and negative aspects of venture capital funds functioning. On the other hand, Ferrary and Granovetter [5] analysed an interesting case study concerning the role of venture capital funds in creation of comprehensive network of innovations in Silicon Valley in the USA. Among the Polish researchers the interesting articles were presented by among others Fałat-Kilijańska [4], Szydłowski [16] and Włodarska-Zoła [20]. The research on the subject can also be found in the studies by Czerniak [1] and Weresa [19] who apart from empirical research present the recommendations concerning innovative policy in supporting venture capital funds development [6].

## **2 The Aim, Methodology and the Area of Research**

The aim of the article is a classification of the European Union countries and their main economic competitors due to the level of development of the venture capital market.

The theoretical part of the article deals with the issue of factors determining the functioning and development of the venture capital market in the theory of economics. In the further part of the article addresses an issue of development of venture capital market in the European Union and the selected countries of the world economy in the years 2012 and 2016. The issue of venture capital investments as % of GDP and availability of financing from the venture capital funds is also clarified.

In the further part of the study the empirical research was conducted with the use of Ward's method, which is a recursive method. At the first step the distances between all the observation pairs (in this case between each pair of countries) are calculated. The Euclidean distance, in our case, the distance between  $i$  and  $j$  country, named  $d_{ij}$  is defined by the following equation:

$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \quad (1)$$

In the above equation  $x_i$  is (standardised) financial availability from the venture capital funds in the years 2016-2017 in the  $i$  country, and  $y_i$  is (standardised) venture capital investments as % of GDP in 2016 in the country. The situation is similar in  $j$  country.

At the second step a pair of countries is selected for which the distance described above is the smallest. They are combined in a group (cluster). The distance of this group from the  $k$  group is calculated with the use of the equation:

$$d_{(ij)k} = \frac{n_i + n_k}{n_i + n_j + n_k} d_{ik} + \frac{n_j + n_k}{n_i + n_j + n_k} d_{jk} - \frac{n_k}{n_i + n_j + n_k} d_{ij} \quad (2)$$

where  $n_i, n_j$  i  $n_k$  are number of clusters.

The second step is repeated until all the observations (in this case countries) will be in the same cluster.

In order to answer a question for how many groups to finally divide the countries, so called scree plot is used or the elbow method. It is based on the fact that the distance (calculated vertically) between branches is strictly connected with the clusters similarity for which these branches divide our group the more the cluster differs. It may be concluded that it is worth dividing as long as the branches are relatively distant from each other (on a vertical coordinate).

### 3 Conditions for the Venture Capital Market Development

The search of the literature on the subject indicates a very frequent use of terms venture capital and private equity interchangeably. However, it should be emphasized that these terms are not identical, as the private equity is a more capacious term and concerns the capital investments made at all phases of the enterprise development, often with the willingness to participate in the direct management of this enterprise. On the other hand, the venture capital funds investments are intended for the early phase of the enterprise development [20]. The following stages of private equity/venture capital funds investments can be identified:

- The phase of sowing (the incubation capital, *seed capital*). This type of investments is undertaken in order to finance a very early stage of the given enterprise implementation. This phase refers to all the activities connected with starting the company's activity, such as e.g.: preparation of a product concept, market investigation, building the senior management team and creation of a business plan. This phase is characterised by a very high level of risk undertaken by the seed capital funds.

- The start-up phase (the initial capital, *start-up financing*). This stage refers to finalisation of the formal procedures referring to starting a company and the works connected with developing a product and marketing preparation. At this stage the company may have some experience with selling a product although not at a commercial scale. The degree of taken risk is certainly lower than in the sowing phase.
- The phase of early development (*early-stage financing*). This stage is characterised by the completion of the product development, although it should be emphasized that the company does not generate profit. The financial resources are allocated for starting up production and selling at the market scale. This stage is characterised by a lower level of risk than at the previous stages and the need of incurring increased capital expenditures.
- The expansion phase (*expansion financing*). The investments are directed to enterprises with the established market position, which are able to finance their current activity by themselves. The resources disbursed from the funds are allocated for the financing of the increase of production and marketing activities as well as for increasing working capital.

The investment process of venture capital funds is characterised by cyclicity and may be divided into four main stages [14]:

- Stage I: Raising capital;
- Stage II: The preliminary analysis and selection of potential investment projects and undertaking the investment;
- Stage III: The period of investment implementation;
- Stage IV: Leaving of the investment and realisation of portfolio profits.

The functioning of venture capital funds is limited to serving as a financial intermediary between investors and private enterprises that search for a capital for development. These enterprises are unlisted innovative companies which often operate in the advanced technologies industries. The venture capital funds aim at giving an assistance to developing enterprises during their growth until they reach the stage when they are ready to enter the stock exchange. After obtaining shares in such an enterprise venture capital funds give resources for their development and assume a part of the risk connected with completing the enterprise. It should be noted, that venture capital funds are not directly involved in the company management but undertake monitoring and supervision of its activity by an active participation in the supervisory boards. The investment period has medium or long character and after fixed period of investment there is a disinvestment (*exit*), that is a sale of shares through introducing an enterprise on the stock exchange or their divestiture on the over the counter market [24]. It should be emphasized that each capital investment in innovative enterprise creates a necessity of deep analysis both an investor and a capital receiver. The investor should assess a chance of success of the undertaken innovative enterprise and possibilities of profit generation. As the primary assessment criterion may be a return rate from the invested financial resources or unearned increment rate of the enterprise from the implemented innovative project [15].

#### 4 Development of the Venture Capital Market in the European Union and Selected Countries of the World Economy

The value of the capital invested by the venture capital funds is different across countries. The American venture capital market is recognized as the biggest and it was a pioneer of such type of financing and is much more developed than its European equivalent [19]. According to the data for 2016 the value of the American venture capital market amounted to 66 626 mln USD and the European nearly 4 745 mln USD. In terms of amount of invested funding the European leaders are Germany, France and Great Britain with their investments amounted respectively to 1 051, 894 and 761 mln USD. At a global level, highly developed venture capital markets are Canada (2 377 mln USD), Japan (1 367 mln USD), South Korea (1 212 mln USD) and Israel (1 165 mln USD). Compared to both European and world economies the Polish result is very modest (23 mln USD) [6, 12].

**Table 1.** Venture capital investments as % of GDP in selected countries in the years 2012 and 2016 [8, 12, 13].

Country	2012	2016	Country	2012	2016
Austria	0.011	0.01446	Poland	0.002	0.00505
Belgium	0.024	0.02801	Portugal	0.01	0.00817
Bulgaria	l.d.	0.012	Romania	l.d.	0.001
Croatia	l.d.	l.d.	Slovakia	l.d.	0.01232
Cyprus	l.d.	l.d.	Slovenia	0.005	0.00746
the Czech Republic	0.003	0.00241	Sweden	0.054	0.0404
Denmark	0.032	0.03066	Great Britain	0.038	0.02906
Estonia	0.008336	0.03111	Hungary	0.066	0.0278
Finland	0.041	0.05053	Italy	0.005	0.00523
France	0.027	0.03633	Australia	0.021	0.00916
Greece	0.005	0	Israel	0.36	0.26557
Spain	0.011	0.03624	Japan	0.026	0.01938
the Netherlands	0.029	0.02648	Canada	0.08	0.08733
Ireland	0.054	0.07718	South Korea	0.054	l.d.
Lithuania	l.d.	l.d.	Norway	0.029	0.01463
Luxembourg	0.025	0.00133	Russia	0.014	l.d.
Latvia	l.d.	0.03153	the Republic of South Africa	0.0273	l.d.
Malta	l.d.	l.d.	The United States	0.171	0.13999
Germany	0.021	0.03034	Switzerland	0.033	0.029

l.d. – lack of data

An investment activity of venture capital funds in a given economy can be identified by approximation of their value in relations to the amount of GDP. Within the countries included in the analysis large disparities are noticeable in the achieved results. The best results in 2016 had Israel (0.266%), the United States (0.14%) and



Canada (0.087%). Nevertheless, it should be noticed that in case of leader and vice-leader a significant decrease was noticed compared to 2012. Among the UE member states the best results had Ireland (0.077%) and two Scandinavian countries – Finland (0.051%) and Sweden (0.04%). In this case both leader and vice-leader significantly improved the value of the index compared to 2012. A moderately high value of venture capital investments as % of GDP (about 0.030-0.036%) bore in 2016 Spain, France, Latvia, Estonia, Denmark and Germany. Unfortunately, Poland is not among these countries and with the result amounted to 0.005% is among the weakest the EU member states (table 1).

**Table 2.** Availability of financing from venture capital funds in the selected countries in the years 2012 and 2016 [17, 18].

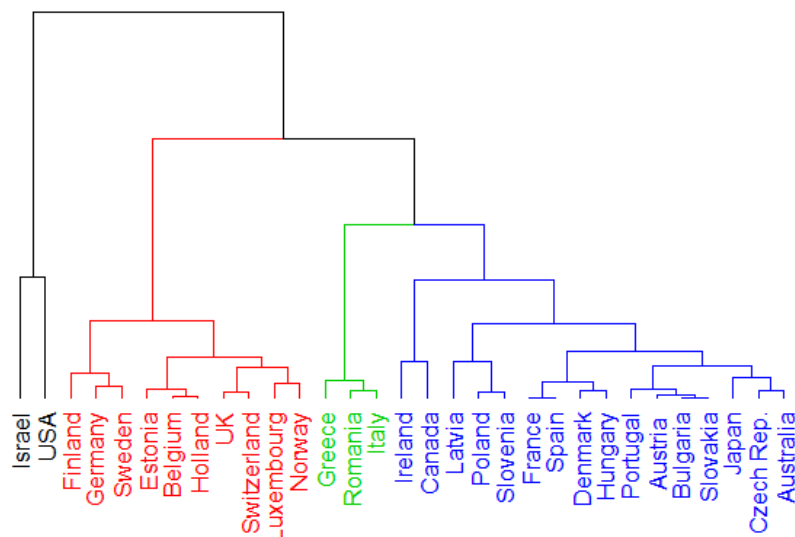
Country	2012	2016	Country	2012	2016
Austria	2,8	3,2	Poland	2,3	2,8
Belgium	3,3	3,9	Portugal	2,2	3,1
Bulgaria	2,7	3,2	Romania	2,4	2,1
Croatia	2,2	2,3	Slovakia	2,7	3,2
Cyprus	2,8	2,4	Slovenia	2	2,9
The Czech Republic	2,6	3,4	Sweden	4,3	4,5
Denmark	2,4	3,2	Great Britain	3,5	4,3
Estonia	3,3	3,8	Hungary	2,1	3,3
Finland	4	4,8	Italy	1,8	2
France	2,9	3,4	Australia	3,6	3,4
Greece	1,7	1,8	Israel	4,2	5,1
Spain	2,3	3,4	Japan	3,1	3,6
the Netherland	3,5	3,9	Canada	3,4	3,7
Ireland	2,7	3,1	South Korea	2,1	2,9
Lithuania	2,5	3	Norway	4,3	4,1
Luxembourg	4	4,2	Russia	2,6	2,6
Latvia	2,8	2,5	the Republic of	3,3	2,9
Malta	3,2	3,2	South Africa		
Germany	3,2	4,6	the United States	4,3	5,2
			Switzerland	3,4	4,2

An interesting source of information about the high-risk capital market development in the most of the world countries is the study conducted for *The Global Competitiveness Report 2017-2018*. The entrepreneurs surveyed in the study express their opinions on the possibilities to acquire support from venture capital funds by giving ratings on a scale from 1 to 7. The bigger venture capital financing availability, according to the entrepreneurs, the rating is higher. In 2016 venture capital funds were the most easily available in the United States and Israel where the entrepreneurs assessed their availability respectively for 5,2 and 5,1, and they were the only countries in the ranking that obtained the rating higher than 5. The countries that obtained rating higher than 4 also should be mentioned: Finland (4,8), Germany (4,6), Sweden (4,5), Great Britain (4,3), Luxembourg (4,2), Switzerland (4,2) and Norway (4,1). It is worth emphasizing that in all mentioned countries, apart from Norway,

there is an improvement compared to 2012. Poland received 2,8 and in only 7 countries from the 38 studied the venture capital funds availability was assessed worse. Comparing the results from all the countries in the years 2012 and 2016 according to the entrepreneurs a larger availability of venture capital may be noticed. There is an improvement in 30 countries, deterioration in 6 countries (Cyprus, Latvia, Romania, Australia, Norway, the South Africa Republic), and in 2 countries nothing changed (Russia, Malta) (table 2), [6, 17, 18].

In order to conduct the analysis of clusters of the European Union member states and the selected world countries on the grounds of the similarity of the venture capital market development the Ward's method was applied with the use of two variables: availability of financing from the venture capital funds in the years 2016-2017 and the venture capital investments as % of GDP in 2016 (figure 1).

Before the analysis a standardization (by subtracting the average and dividing by standard deviation) both analysed variables in such a way that each of them has the same weight in the process of cluster search. The dendrogram resulting from this analysis is presented below.



**Fig. 1.** The results of grouping of the European Union member countries and the selected world countries concerning the similarities of the venture capital market.

The following clusters were selected on the basis of the analysis of the scree:

- cluster one (Israel and the USA) – group A cluster;
- cluster two (Finland, Germany, Sweden, Estonia, Belgium, the Netherlands, Great Britain, Switzerland, Luxembourg, Norway) – group B;
- green cluster (Greece, Romania, Italy) – group C;

- blue cluster (Ireland, Canada, Latvia, Poland, Slovenia, France, Spain, Denmark, Hungary, Portugal, Austria, Bulgaria, Slovakia, Japan, the Czech Republic, Australia) – group C.

To describe them we see the values used for variables analysed divided into four groups. The results of the post-hoc tests present the following general image (table 3):

- group A includes the countries with the highest VC financial availability and the biggest share of VC in GDP;
- group B includes the countries with a bit lower VC financial availability and a lower share of VC in GDP compared to group A countries;
- group C includes the countries with the lowest VC financial availability and the lowest share of VC in GDP;
- group D includes the countries with a lower VC financial availability than in groups A and B and a higher than in C, and the share of VC in GDP lower than in group A but higher than in C.

**Table 3.** The results of basic statistics for the variable of financial availability from the venture capital funds in the years 2016-2017 and the variable of venture capital investment as % of GDP in 2016.

Variable		Group A	Group B	Group C	Group D	p*
Availability of financing from venture capital funds in 2016-2017	av±SD	5,15±0,07	4,23±0,33	1,97±0,15	3,21±0,3	<0,001
	Median	5,15	4,2	2	3,2	P
	Quartiles	5,12-5,18	3,95-4,45	1,9-2,05	3,1-3,4	A>B>D>C
Venture capital investments as % of GDP in 2016	av±SD	0,2±0,09	0,03±0,01	0±0	0,03±0,02	0,008
	Median	0,2	0,03	0	0,02	NP
	Quartiles	0,17-0,23	0,03-0,03	0-0	0,01-0,03	A>D,C B,D>C

\* P = Normal distribution in the groups, test t-student; NP = lack of normality of distribution in the groups, Mann-Whitney's test

\* P = Normal distribution in the groups, ANOVA + post-hoc analysis results (Fisher's LSD test); NP = Lack of normal distribution in the groups, Kruskal-Wallis's test + post-hoc analysis results (Dunn's test)..

## 5 Conclusions

In case of new or young investment firms the condition to achieve success of effective development and introducing a product into the market is possibility to gain the external source of project financing. Taking into account the high risk of the enterprise failure and lack of credit capacity the traditional financing institutions like banks are not interested to finance such projects. A panacea for a lack of capital is a functioning of venture capital market that includes the private investors ready to take high risk in exchange for possibility to obtain over average return rate.

On the basis of the conducted cluster analysis the following synthetic final conclusions may be formulated:

- At the global scale the most developed venture capital markets are the American and Israeli markets, which are in different group of countries. These markets are characterised by the highest financial availability of venture capital and the biggest share of venture capital in GDP. In the United States and Israel, the great importance is given to entrepreneurship development, promotion of innovative enterprises implemented by the new, or functioning for a few years on the market, companies.
- The venture capital markets of high level of development but lower than in case of the United States and Israel are functioning in: Belgium, Estonia, Finland, the Netherlands, Luxembourg, Germany, Norway, Switzerland, Sweden and Great Britain. It is significant that these countries also achieve very good results in various rankings of economy innovation which results, to some degree, from a very well-developed venture capital market.
- The least developed venture capital markets include Greek, Romanian and Italian markets where the potential investors find it difficult to apply for financing their projects with the use of venture capital. The situation corresponds with the generally low level of innovation of these countries economy.

## References

1. Czerniak, J.: Polityka innowacyjna, Difin, Warszawa (2013).
2. Dessi, R., Yin N.: The Impact of Venture Capital on Innovation. In: Cumming, D. (eds.) The Oxford Handbook of Venture Capital, pp. 668-685. Oxford University Press, New York (2012).
3. Drobny, P.: 2014. Źródła finansowania działalności innowacyjnej przedsiębiorstw w Polsce w latach 2007-2012. In: Przybylska K. (eds.) Uwarunkowania innowacyjności polskich przedsiębiorstw, pp. 113. PWN. Warszawa (2014).
4. Fałat-Kilijańska, I.: Zwiększanie innowacyjności polskiej gospodarki, czyli jak wzmocnić rodzaje inwestycje venture capital. Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, pp. 46-60. (2016).
5. Ferrary, M., Granovetter M.: The role of venture capital firms in Silicon Valley's complex innovation network. Economy and Society, 38:2, pp. 326-359 (2009).
6. Firlej, K. A.: Financing innovations by venture capital funds as a determinant of innovativeness of economy, Ekonomiczne Problemy Usług, (2018).
7. Gompers, P., Lerner J.: The Venture Capital Revolution. Journal of Economic Perspectives, 15 (2), 145-168 (2001).
8. Invest Europe 2017. 2016 European Private Equity Activity, Statistics on Fundraising, Investments & Divestments, Belgium (2017), pp. 47, <https://www.investeurope.eu/media/651727/invest-europe-2016-european-private-equity-activity-final.pdf>, last accessed 2018/05/01.
9. Kornasiewicz, A.: Venture capital w krajach rozwiniętych i w Polsce, pp. 32-36., CeDeWu, Warszawa (2004).
10. Lerner, J.: Boom and bust in the venture capital industry and the impact on innovation, Economic Review, (Q4), 25-39, (2002).
11. OECD, Entrepreneurship at a Glance 2013, OECD Publishing Paris, pp. 89, Paris (2013), <http://dx.doi.org/10.1787/888932829590>, last accessed 2018/05/01.

12. OECD, Entrepreneurship at a Glance 2017, OECD Publishing Paris, p. 125, Paris (2017), <http://dx.doi.org/10.1787/888933565070>, last accessed 2018/05/01.
13. Samuelson, P. A., Nordhaus W. D.: Economics, New York (1985).
14. Sobańska-Helman, K., Sieradzan, P.: Inwestycje private equity/venture capital, p. 27, Key Text, Warszawa (2013).
15. Szatkowski, K.: Zarządzanie innowacjami i transferem technologii, p. 162, PWN, Warszawa (2016).
16. Szydłowski, K.: Rynek kapitału wysokiego ryzyka jako źródło finansowania innowacji w przedsiębiorstwach, In: Buszka A., (eds.), Finansowanie innowacji, pp. 89-108, Uniwersytet Warmińsko-Mazurski, Olsztyn (2013).
17. The Global Competitiveness Report 2013-2014. World Economic Forum, Geneva (2014).
18. The Global Competitiveness Report 2017-2018. World Economic Forum, Geneva (2018).
19. Weresa, M. A.: Polityka innowacyjna, p. 183, PWN, Warszawa (2014).
20. Włodarska-Zoła, L.: Venture capital jako źródło finansowania przedsięwzięć innowacyjnych w świetle polityki wspierania innowacyjności. Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, nr 436, p. 279, Wrocław (2016).

## Kalman Filter and Time Series

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**Abstract.** The Kalman filter is one of the classical algorithms of the statistical estimation theory. The filter is applied in a lot of fields. One of them is econometrics, especially its sphere of econometric models in which there is at least one variable which cannot be directly observed and measured. The paper presents the basic features of the Kalman filter and its application in time series analysis. The text specifically focuses on possibilities of transformations of ARMA models into state-space form, and the following application of the Kalman filter in solving problems of prediction, filtering and smoothing. Another issue which is focused on is an application of the Kalman filter in estimating of unknown parameters of time series models. The presented procedures are demonstrated on practical problems which are implemented in the MATLAB environment; the outputs are presented in the text.

**Keywords:** Kalman Filter, Time Series, ARMA, State-Space Model.

### 1 Introduction

Numerous models of dynamic systems are designed in the theory of economics [22, 5, 13]. And in the process of applying these models, there are frequent cases of situations when one of the model variables (the system state) is not directly observable, is latent. In such a case it is possible to use the Kalman filter.

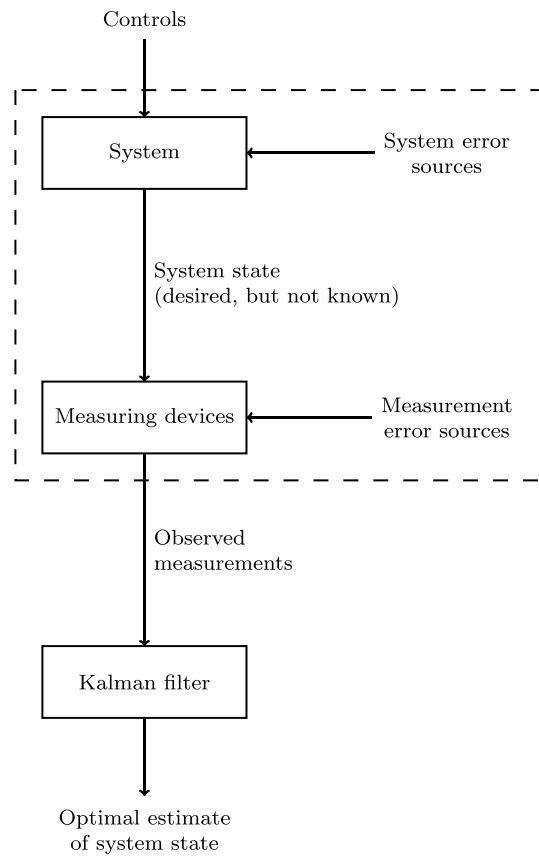
The Kalman filter is considered to be a theoretical basis for various recursive methods applied in stochastic (linear) dynamic systems. The algorithm is based on the idea that an unknown state of the system can be estimated using certain measured data (usually in the form of a time series). The algorithm was named after Rudolf Emil Kalman, a Hungarian mathematician living in the USA, who presented it in 1960 in the text referred to below under [11]. During the course of time, other authors derived other algorithms based on the principle of the Kalman filter, these algorithms are generally referred to as Kalman filters, and they can be conveniently applied in specific situations of solving practical problems in which, for example, some of the theoretical assumptions of the classical Kalman filter are not met.

The Kalman filter can be applied in varied domains of the prevailing technical character, as for example in case of localization of moving objects and navigation – the Kalman filter or Kalman filters in general are used in global navigation satellite systems (GPS, etc.), in radars, in case of navigation and controlling of robots, in autopilots or autonomous vehicles, in computer vision for tracking objects in videos,

in augmented and virtual reality, etc. Their application in the sphere of econometrics cannot be ignored [9, 16, 21, 3]; analysis of economic time series can be mentioned here as a related example [14, 20]. The main goal of the paper is to present the basic features of the Kalman filter and focus on its application in time series analysis.

## 2 Kalman Filter

The Kalman filter is a tool which enables to estimate the state of a stochastic linear dynamic system using measurements corrupted by noise. The estimate produced by the Kalman filter is statistically optimal in some sense (for example when considering the minimization of the mean square error; see [12] for details). The principle of application of the filter is illustrated in Fig. Fig. 1.



**Fig. 1.** Scheme of applying Kalman filter. Based on [12].

The Kalman filter works with all available information, i.e. all the available measurements, the knowledge of the system model and the statistical description of its inaccuracies, noise and errors, and the information about the initial conditions are used when the system state is being estimated.

## 2.1 Algorithm of Kalman Filter

Let us consider a stochastic linear dynamic system in discrete time, which is represented by the following state-space model (it is assumed here that the system has no inputs)

$$\mathbf{x}_k = \Phi_{k-1}\mathbf{x}_{k-1} + \mathbf{G}_{k-1}\mathbf{w}_{k-1}, \quad (1)$$

$$\mathbf{z}_k = \mathbf{H}_k\mathbf{x}_k + \mathbf{v}_k. \quad (2)$$

The equation (1) referred to as the state equation, describes the dynamics of the system, the vector  $\mathbf{x}_k \in \mathbb{R}^n$  is an (unknown) vector of the system state at the time  $t_k$ , the matrix  $\Phi_{k-1} \in \mathbb{R}^{n \times n}$  represents the system state transition between the time  $t_{k-1}$  and  $t_k$ . The equation (2) is called the measurement equation, the vector  $\mathbf{z}_k \in \mathbb{R}^m$  is called the system output vector, the measurement vector or the observation vector, the matrix  $\mathbf{H}_k \in \mathbb{R}^{m \times n}$  describes the relation between the system state and the measurements. Since a stochastic system is concerned, the vectors  $\mathbf{x}_k$  and  $\mathbf{z}_k$ ,  $k = 0, 1, 2, \dots$ , can be considered as random variables, and their sequences  $\{\mathbf{x}_k\}$  and  $\{\mathbf{z}_k\}$  are then random (stochastic) processes.

$\{\mathbf{w}_k\}$  and  $\{\mathbf{v}_k\}$  are random noise processes; these processes are assumed to be uncorrelated Gaussian processes with zero mean and covariance matrices  $\mathbf{Q}_k \in \mathbb{R}^{l \times l}$  resp.  $\mathbf{R}_k \in \mathbb{R}^{m \times m}$  at time  $t_k$  (the processes have qualities of Gaussian white noise). Matrix  $\mathbf{G}_k \in \mathbb{R}^{n \times l}$  then describes the impact of the noise in the state equation of the model.

Furthermore, let us assume that  $\mathbf{x}_0$  is a random variable having a Gaussian (normal) distribution with known mean  $\mathbf{x}_0$  and known covariance matrix  $\mathbf{P}_0$ . Moreover, suppose that  $\mathbf{x}_0$  and both the noises are always mutually uncorrelated. Then we can summarize that for all  $t_k$

$$E\langle \mathbf{w}_k \rangle = \mathbf{0},$$

$$E\langle \mathbf{v}_k \rangle = \mathbf{0},$$

$$E\langle \mathbf{w}_{k_1} \mathbf{w}_{k_2}^T \rangle = \mathbf{Q}_{k_1} \Delta(k_2 - k_1),$$

$$E\langle \mathbf{v}_{k_1} \mathbf{v}_{k_2}^T \rangle = \mathbf{R}_{k_1} \Delta(k_2 - k_1),$$

$$E\langle \mathbf{w}_{k_1} \mathbf{v}_{k_2}^T \rangle = \mathbf{0},$$

$$E\langle \mathbf{x}_0 \mathbf{w}_k^T \rangle = \mathbf{0},$$

$$E\langle \mathbf{x}_0 \mathbf{v}_k^T \rangle = \mathbf{0},$$



where the symbol  $\Delta$  refers to the Kronecker delta

$$\Delta(k) = \begin{cases} 1, & k = 0, \\ 0, & k \neq 0. \end{cases}$$

The aim of the Kalman filter is to produce an estimate of the state vector  $\mathbf{x}_k$  at time  $t_k$ , symbolized as  $\hat{\mathbf{x}}_k$ , so that this estimate is optimal (for example with respect to minimizing the mean square error).

The algorithm of the Kalman filter is recursive, the calculation at time  $t_k$  consists of two main steps. Firstly, the a priori estimate  $\hat{\mathbf{x}}_{k(-)}$  at time  $t_k$  is computed through substituting the a posteriori estimate from time  $t_{k-1}$  into the deterministic part of the state equation of the model; this step is called the prediction step. Then, this estimate is improved by using the measurement carried out at time  $t_k$ , which results in obtaining the a posteriori estimate  $\hat{\mathbf{x}}_{k(+)}$  at time  $t_k$ ; this is the correction step.

The following relation can be written to specify the a priori estimate of the state vector  $\hat{\mathbf{x}}_{k(-)}$  at time  $t_k$ ; the uncertainty of this estimate is expressed by the a priori error covariance matrix  $\mathbf{P}_{k(-)}$

$$\begin{aligned} \hat{\mathbf{x}}_{k(-)} &= \Phi_{k-1} \hat{\mathbf{x}}_{k-1(+)}, \\ \mathbf{P}_{k(-)} &= \Phi_{k-1} \mathbf{P}_{k-1(+)} \Phi_{k-1}^T + \mathbf{G}_{k-1} \mathbf{Q}_{k-1} \mathbf{G}_{k-1}^T. \end{aligned}$$

Then, after obtaining of the measurement  $\mathbf{z}_k$ , combining of the a priori estimate and the difference between the actual value and the predicted value of the measurement weighted by the matrix  $\mathbf{K}_k$ , we come to the a posteriori estimate of the state vector  $\hat{\mathbf{x}}_{k(+)}$ ; its uncertainty is expressed by the a posteriori error covariance matrix  $\mathbf{P}_{k(+)}$

$$\begin{aligned} \hat{\mathbf{x}}_{k(+)} &= \hat{\mathbf{x}}_{k(-)} + \mathbf{K}_k [\mathbf{z}_k - \mathbf{H}_k \hat{\mathbf{x}}_{k(-)}], \\ \mathbf{P}_{k(+)} &= \mathbf{P}_{k(-)} - \mathbf{K}_k \mathbf{H}_k \mathbf{P}_{k(-)}, \\ \mathbf{K}_k &= \mathbf{P}_{k(-)} \mathbf{H}_k^T [\mathbf{H}_k \mathbf{P}_{k(-)} \mathbf{H}_k^T + \mathbf{R}_k]^{-1}. \end{aligned}$$

A detailed derivation of the given equations of the Kalman filter can be found for example in [6], more detailed presentations of the algorithm, its features and its theoretical assumptions can be found for example in [6, 12, 17]; practical aspects of the implementation of the filter are discussed for example in [17].

### 3 Application of Kalman Filter in Time Series Analysis

The Kalman filter can be conveniently applied when solving the problems of prediction, filtering and smoothing [2, 4, 7, 8]. Prediction is based on the estimation of the system state at certain time while using observations measured at times preceding the time of the estimation; it can be shortly written as ( $t_{\text{observation}} < t_{\text{estimation}}$ ). Filtering is based on the estimation of the system state at certain time while using observations measured at that given estimation time and preceding times

( $t_{\text{observation}} \leq t_{\text{estimation}}$ ). Smoothing is based on the estimation of the system state at certain time while using observations measured at times after the time of the estimation ( $t_{\text{observation}} > t_{\text{estimation}}$ ).

So called ARMA (autoregressive moving average) models or their other more general variants are often used when time series are analyzed. These models, however, can be transformed into the form of the state-space model consisting of the state equation and the measurement equation; the Kalman filter can be then applied to this model. Related to the construction of time series models, the Kalman filter can be further involved in calculating the estimates of the unknown parameters of these models [7, 8].

### 3.1 Estimation of Parameters of Time Series Models

For the time being, let us consider merely the autoregressive model AR( $p$ ) of the  $p$  order

$$y_t = \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + \varepsilon_t,$$

where  $\{\varepsilon_t\}$  is an uncorrelated Gaussian process with zero mean and constant variance  $\sigma^2$ , and  $\phi_i, i = 1, \dots, p$ , are the parameters of the model. (The used symbols are in accordance with the established practice of time series models.)

Now, the aim can be estimating of the model's parameters. When solving this problem, the parameters form the unknown state vector, and the whole state equation (supposing that the parameters are constant in time) and the measurement equation can be expressed in the following way

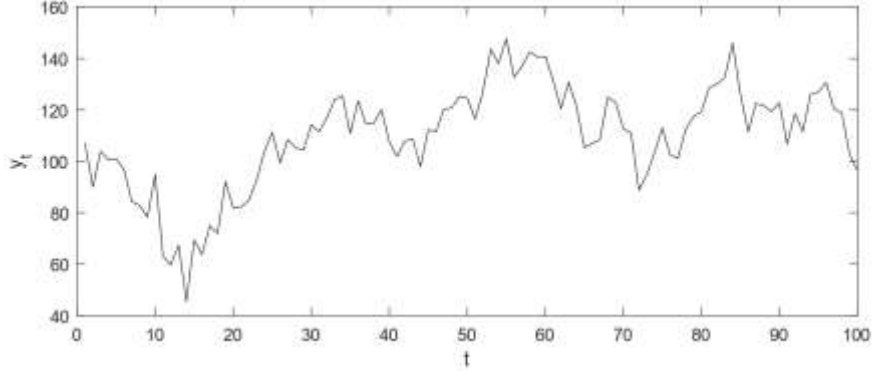
$$\begin{pmatrix} \phi_1 \\ \phi_2 \\ \vdots \\ \phi_p \end{pmatrix} = \begin{pmatrix} \phi_1 \\ \phi_2 \\ \vdots \\ \phi_p \end{pmatrix},$$

$$y_t = (y_{t-1} \quad y_{t-2} \quad \cdots \quad y_{t-p}) \begin{pmatrix} \phi_1 \\ \phi_2 \\ \vdots \\ \phi_p \end{pmatrix} + \varepsilon_t.$$

The problem can be illustrated on a simulated AR(2) process

$$y_t = 0.7y_{t-1} + 0.3y_{t-2} + \varepsilon_t, \quad \varepsilon_t \sim N(0, 10), \quad t = 1, \dots, 100,$$

whose possible realization is depicted in Fig Fig. 2.



**Fig. 2.** Simulated AR(2) process.

Only the values  $y_t$  are available as the input of the problem, the parameters  $\phi_1$  and  $\phi_2$  are unknown. On the basis of the above given, the state equation and the measurement equation were constructed, and the Kalman filter was then applied. The evolution of the obtained estimates of the parameters is summarized in Table Table 1. Estimates of the parameters of the AR(2) model obtained through Kalman filter. (the initial values of the estimates could be chosen arbitrarily).

**Table 1.** Estimates of the parameters of the AR(2) model obtained through Kalman filter.

$t$	0	10	20	30	40	50	60	70	80	90	100
$\hat{\phi}_1$	1.000	0.521	0.458	0.541	0.523	0.553	0.572	0.631	0.680	0.706	0.704
$\hat{\phi}_2$	1.000	0.465	0.523	0.465	0.480	0.453	0.437	0.369	0.320	0.295	0.293

### 3.2 Prediction, filtering and smoothing of time series

The issue of solving the already mentioned problems of prediction, filtering and smoothing will now be discussed. For these purposes, the already presented AR( $p$ ) model can be transformed into the form of a state-space model, for example, of the following form

$$\begin{pmatrix} y_t \\ y_{t-1} \\ \vdots \\ y_{t-p+2} \\ y_{t-p+1} \end{pmatrix} = \begin{pmatrix} \phi_1 & \phi_2 & \cdots & \phi_{p-1} & \phi_p \\ 1 & 0 & \cdots & 0 & 0 \\ 0 & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & 1 & 0 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ y_{t-2} \\ \vdots \\ y_{t-p+1} \\ y_{t-p} \end{pmatrix} + \begin{pmatrix} 1 \\ 0 \\ \vdots \\ 0 \\ 0 \end{pmatrix} \varepsilon_t,$$

$$y_t = (1 \quad 0 \quad \cdots \quad 0 \quad 0) \begin{pmatrix} y_t \\ y_{t-1} \\ \vdots \\ y_{t-p+2} \\ y_{t-p+1} \end{pmatrix}.$$

Also a more general ARMA( $p, q$ ) model

$$y_t = \phi_1 y_{t-1} + \phi_2 y_{t-2} + \dots + \phi_p y_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \dots + \theta_q \varepsilon_{t-q}.$$

can be transformed into the form of the state-space model. That can result, for example, in the following state equation and measurement equation [4, 8]

$$\alpha_t = \begin{pmatrix} \phi_1 & 1 & 0 & \dots & 0 \\ \phi_2 & 0 & 1 & \dots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \phi_{n-1} & 0 & \dots & 0 & 1 \\ \phi_n & 0 & 0 & \dots & 0 \end{pmatrix} \alpha_{t-1} + \begin{pmatrix} 1 \\ \theta_1 \\ \vdots \\ \theta_{n-2} \\ \theta_{n-1} \end{pmatrix} \varepsilon_t,$$

$$y_t = (1 \quad 0 \quad \dots \quad 0 \quad 0) \alpha_t,$$

where

$$\alpha_t = \begin{pmatrix} y_t \\ \phi_2 y_{t-1} + \dots + \phi_n y_{t-n+1} + \theta_1 \varepsilon_t + \dots + \theta_{n-1} \varepsilon_{t-n+2} \\ \vdots \\ \phi_n y_{t-1} + \theta_{n-1} \varepsilon_t \end{pmatrix}, \quad n = \max(p, q + 1),$$

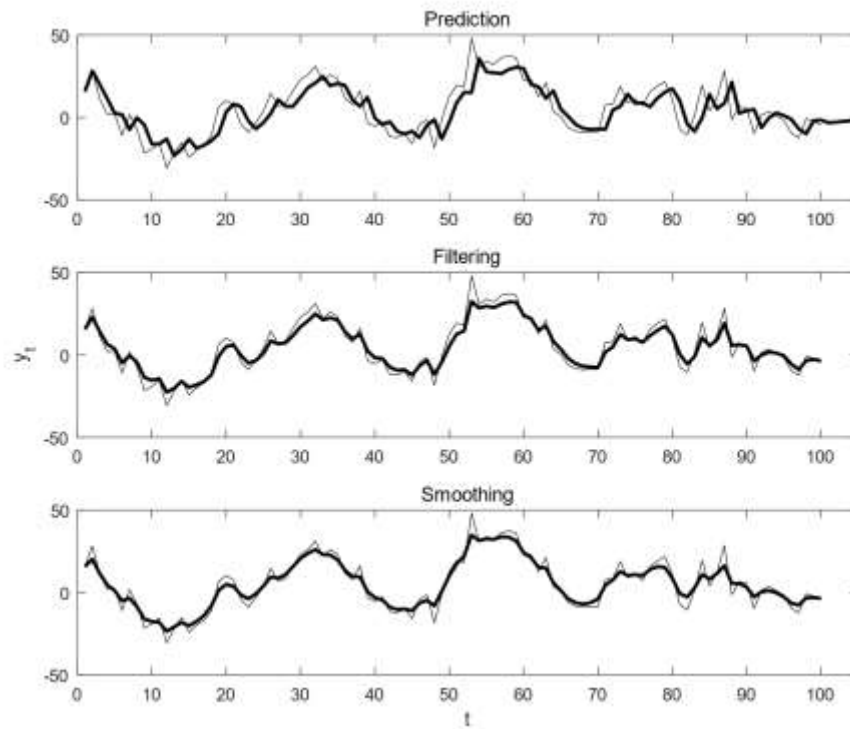
$\phi_i = 0$  for  $i > p$ , and  $\theta_i = 0$  for  $i > q$ .

However, it is necessary to mention the existence of a bigger number of alternative state-space models representing the same ARMA model; they differ from each other in their definitions of the state vector etc. These varied approaches are summarized in [10]. However, the state vectors defined in this way do not generally have a substantive interpretation.

The problem of prediction, filtering and smoothing will be demonstrated on a simulated ARMA(2,1) process

$$y_t = 0.6y_{t-1} + 0.2y_{t-2} + \varepsilon_t + 0.1\varepsilon_{t-1}, \quad \varepsilon_t \sim N(0, 10), \quad t = 1, \dots, 100.$$

In accordance with the above given, this ARMA model was transformed into the form of a state-space model. The problem of filtering was solved through a standard application of the algorithm of the Kalman filter (the prediction step and the correction step), as it was described in Section 2. The problem of prediction can be solved through applying merely the prediction step of the algorithm. This step is not followed by the correction step because the observation (measurement) which could improve the a priori estimate is not available yet (in the practical illustration, one-step ahead predictions were calculated in the observed period, and then predictions for five future times were calculated). The problem of smoothing can be solved in various ways. Here the application of the algorithm called the Rauch–Tung–Striebel smoother was used. In the first (forward) pass, the smoother applies the standard Kalman filter, and in the second (backward) pass, it processes recursively from the end, and by combining the filtered values, it computes smoothed values [15]. The obtained results are summarized in Fig. Fig. 3.



**Fig. 3.** Illustration of applying the Kalman filter for prediction, filtering and smoothing of a time series represented by ARMA(2,1) model.

## 4 Conclusion

Time series are essentially important in the sphere of dynamic models in economics. It is quite frequently necessary to estimate unobservable parameters of time series models, which can be done on the basis of observed values of economic variables. The paper presented some ways in which the Kalman filter can be used for estimating the  $AR(p)$  model's parameters. A model of a simulated  $AR(2)$  process was used as a practical demonstration of this problem. From the results presented in Table 1 it is clear that the longer the observed series is, the better the estimates of the parameters of the model can be. Furthermore, using of the Kalman filter for solving problems of prediction, filtering and smoothing of time series was mentioned. The paper presented possible transformations of the  $AR(p)$  models or, more generally, the  $ARMA(p,q)$  models into the state-space model to which the Kalman filter can be applied. A model of a simulated  $ARMA(2,1)$  process was presented as a practical demonstration. The outputs were graphically illustrated in Fig. 3, and it is clear from them that the

results obtained from the application of the Kalman filter are suitable for simulated data.

The application of the Kalman filter in economics is convenient in the sphere of the estimation of the output gap of economic units [19, 1, 8], when the estimate of the position of the economic unit within the framework of the economic cycle is determined. Another convenient application can be in the field of financial estimations – to decide whether the currency policy of the given economy is restrictive or expansive [18] when determining the short-term or long-term interest rate. Our future research will focus on these issues and on mutual comparisons of the situation existing in the V4 countries.

**Acknowledgements.** Support of the Specific research project of the Faculty of Informatics and Management of the University of Hradec Kralove is kindly acknowledged.

## References

1. Beneš, J., N'Diaye, P.: A multivariate filter for measuring potential output and the NAIRU: application to the Czech Republic. IMF Working Paper, WP/04/45 (2004).
2. Brockwell, P. J., Davis, R. A.: Introduction to time series and forecasting. 3rd edn. Springer, Cham (2016).
3. Cipra, T.: Finanční ekonometrie. 2nd edn. Ekopress, Praha (2013).
4. Durbin, J., Koopman, S. J.: Time series analysis by state space methods. 2nd edn. Oxford University Press, Oxford (2012).
5. Gandolfo, G.: Economics dynamics. 4th edn. Springer, Heidelberg (2009).
6. Grewal, M. S., Andrews, A. P.: Kalman filtering: theory and practice using MATLAB. 3rd edn. Wiley, Hoboken, NJ (2008).
7. Hamilton, J. D.: Time series analysis. 1st edn. Princeton University Press, Princeton, NJ (1994).
8. Harvey, A. C.: Forecasting, structural time series models and the Kalman filter. 1st edn. (Reprinted). Cambridge University Press, Cambridge (1990).
9. Harvey, A.: Applications of the Kalman filter in econometrics. In: Bewley, T. (eds.) Advances in Econometrics: Fifth World Congress, pp. 285–312. Cambridge University Press, Cambridge (1987).
10. Jong, P., Penzer, J.: The ARMA model in state space form. Statistics & Probability Letters, 70(1), 119–125 (2004). DOI: 10.1016/j.spl.2004.08.006.
11. Kalman, R. E.: A new approach to linear filtering and prediction problems. Transactions of the American Society of Mechanical Engineers, Series D: Journal of Basic Engineering, 82(1), 35–45 (1960). DOI: 10.1115/1.3662552.
12. Maybeck, P. S.: Stochastic models, estimation and control, Volume I. 1st edn. Academic Press, New York (1979).
13. Pražák, P., Kovárník, J.: Nonlinear phenomena in Cournot duopoly model. Systems 6(3), 1–15 (2018). DOI: 10.3390/systems6030030.
14. Rajan, M. P., Mathew J.: Kalman filter and financial time series analysis. In: Mathew J. et al. (eds.) ICECCS 2012, CCIS, vol. 305, pp. 339–351. Springer, Berlin, Heidelberg (2012).

15. Rauch, H. E., Striebel, C. T., Tung, F.: Maximum likelihood estimates of linear dynamic systems. *AIAA Journal*, 3(8), 1445–1450 (1965). DOI: 10.2514/3.3166.
16. Schneider, W.: Analytical uses of Kalman filtering in econometrics - A survey. *Statistical Papers* 29(1), 3–33 (1988). DOI: 10.1007/BF02924508.
17. Simon, D.: Optimal state estimation: Kalman,  $H_\infty$  and nonlinear approaches. 1st edn. Wiley, Hoboken, NJ (2006).
18. Slavík, M.: Úvod do moderních přístupů analýzy časových řad: stavové prostorové modely a Kalmanův filtr. *Politická ekonomie* 53(1), (2005). DOI: 10.18267/j.polek.499.
19. Vlček, J.: Odhad parametrů modelů ve stavovém tvaru. *Finance a úvěr* 52(5), 275–286 (2002).
20. Walker, D. M.: Kalman filtering of time series data. In: Soofi, A. S., Cao, L. (eds.) *Modelling and forecasting financial data*, pp. 137–157. Springer, Boston, MA (2002).
21. Wilcox, B. A., Hamano, F.: Kalman's expanding influence in the econometrics discipline. *IFAC-PapersOnLine* 50(1), 637–644 (2017). DOI: 10.1016/j.ifacol.2017.08.106.
22. Zhang, W.-B.: Discrete dynamical systems, bifurcation and chaos in economics. 1st edn. Elsevier, Amsterdam (2006).

## Tax Costs Related to Functioning of Selected Intangible Assets

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**Abstract.** This article presents selected issues from tax costs related to functioning of intellectual property rights. This topic is especially important in the era of economy based on knowledge. In the first part of the considerations the focus was set on showing the definition of the concept of intangible assets in both domestic and foreign literature, then the components of intellectual property rights and their amortization according to tax law were discussed. The tax law allows amortization of intangible assets. Most of the companies using intangible assets amortize trademarks. To start recognizing depreciation of costs, one needs to face a number of other requirements for the recording of intangible assets. The company must acquire non-tangible assets. They can not produce them on their own and later depreciate them, because the cost of depreciation of intangible assets could not be included in operating expenses. Conditions of depreciation of cost is the fact, that the intangible assets are owned by the company. They can not be a subject to a lease contract. Entrepreneurs often use intangible assets to distinguish their activities from other companies. After detailed presentation of the issue of intangible assets, the conclusions from the analysis are presented.

**Keywords:** Intellectual Property Law, Depreciation, Costs.

### 1 Aim and Methodology of Introducing the Topic of Intangible Assets

Business units conducting economic activity in Poland undergo tax jurisdiction in terms of earned income. Depending on the legal form of the business conducted by the entrepreneur, tax law provides various tax structures for taxation of positive financial results. Particularly noteworthy are tax costs, which must be in a reliable and uncertain manner provided in the settlement of the financial result. Tax law written in:

- Act on corporate income tax,
- Act on personal income tax,

treats costs very restrictively, often not allowing the taxpayer to include certain expenses into the category of costs. The taxpayer must carefully calculate income tax



in order to properly meet his obligations in terms of costs. The economic category - costs - concerns mainly the company's fixed assets. Expresses their consumption in a time perspective, which is usually settled annually. Among all assets, non-material assets deserve recognition, which are increasingly used in the course of business.

The aim of the article is to present a very wide issue of tax costs related to the functioning of selected components of intangible assets. Entrepreneurs are primarily interested in the use of intellectual property rights, because to a large extent, it allows them to achieve a competitive advantage and at the same time to achieve tax benefits. It allows one to combine business goals with tax goals. However, this topic is very difficult to apply in practice due to complicated tax law regulating these issues. The applied research methods in the article include:

- literature studies concerning the issues of intellectual property rights and tax regulations relating to them,
- a descriptive method used to identify tax structures relating to the costs of amortization of intellectual property rights.

The article presents the legal status on the day 01.06.2018

## **2 The Concept of Intangible Assets and their Importance in the Resources of the Enterprise**

Intangible assets are increasingly used by large business entities to strengthen their competitive advantage. The fact of having such resources forces them to thoroughly analyse tax regulations in order to limit the tax risk resulting from inadequate records of intangible assets and, therefore, unreliable presentation of depreciation costs. Many economists emphasize the importance of intangible assets in business. Urbanek emphasizes that enterprises that want to create significant and lasting value for shareholders or other interest groups must pay attention not only to short-term financial results, but also to create business activity, which is primarily determined by intangible assets [8].

In foreign literature, the term intangible assets is often used to describe intangible assets, which are understood as assets that are not monetary and physical substance [1]. In this regard, they also speak about Ch. Chareonsuk and Ch. Chansa-ngavej, who say that during the industrial revolution the emphasis was placed on material assets, whereas now interest has turned to non-material assets [2].

In turn, E. Stańczyk-Hugiart and S. Stańczyk also perceive sources of competitive advantage in intangible assets. In addition, they believe that they have benefited from this in the form of quick access to these assets [6].

A. Jarugowa and J. Fijałkowska on the pages of their study believe that the enterprise's existence depends primarily on how to collect, generate, process and use information. According to these economists, the most important is the fact that information on intangible assets is quickly used [3].

The fact of having such resources forces them to thoroughly analyze tax regulations in order to limit the tax risk resulting from inadequate records of intangible assets and, therefore, unreliable presentation of depreciation costs. Modern publications by G.

Michaleczuk from the University of Białystok also talk about the importance of intangible assets. They indicate that the economic success achieved by economic units is not dependent on traditional resources. To a large extent, intangible assets are responsible for the well-being of business, which is the consequence of the existence of knowledge and its embodiment. It considers non-physical assets as knowledge-based resources that are unique and capable of generating potential benefits, as well as additional resources controlled or controlled by the enterprise. Among intangible assets, the author distinguishes two groups:

- individually identifiable, i.e. they have a separate economic and legal existence, so-called "hard" resources being the subject of intellectual property, e.g. patents, utility models, software, databases and other rights, e.g. rights to radio frequencies,
- individually identifiable, in the sense of their separation from the enterprise, i.e. "soft" resources, eg assets relating to people, assets related to processes, assets relating to relationships [5].

As it results from the several intangible asset definitions presented here, they are increasingly important in creating the value of the enterprise. The greatest ability to generate economic benefits for a business entity are assigned to them [4].

Analysed literature as well as economic practice shows that intangible assets are increasingly important in the course of business. Particularly noteworthy are intellectual property rights, which in a very visible way allow one to improve business, as well as tax savings. To do this it is necessary to properly recognize such assets, their depreciation, which will ultimately affect the financial result for taxation. As a result, business owners are interested in purchasing intellectual property rights that are the product of human labour for business purposes.

The purchase of such a right involves large financial benefits due to high depreciation costs, which are included in the tax-deductible costs.

However, before the issue of tax costs of selected intangible assets is presented in this article, it is necessary to discuss their substance in the light of tax law.

The doctrine of law treats intellectual property very carefully. D. Zak writes in his arguments that this is a very broad concept, which includes in its frames objects of protection resulting from copyright and industrial property, which may become the result of products on the market [12]. The doctrine of the law of intellectual property treats:

- in a narrow sense, which is limited to works as copyright objects [10],
- in broad terms we talk about industrial property rights, ie: inventions, industrial designs, rationalization projects, geographical indications, topographies of integrated circuits, utility models, trademarks [11].

In international terms, the concept of intellectual property has been precisely defined in the Agreement on Trade-Related Aspects of Intellectual Property (Agreement, 1994). In accordance with this legal act, intellectual property resources include: works in the sense of copyright, data sets (databases), computer programs, trademarks, geographical indications, industrial designs, patents, designs (topographies) of integrated circuits.

### **3 Discussion about the Intellectual Property Law in the Light of the Tax Law**

In the light of tax law, i.e. the Personal Income Tax Act and the Corporate Income Tax Act, intellectual property rights are recognized in non-current assets, in particular intangible assets. The aforementioned acts, however, do not contain a literal definition of the term in their content. The Act on Income Taxes speaks only of amortization of purchased goods suitable for commercial use on the day of their acceptance for use:

- a cooperative ownership right to a dwelling,
- cooperative right to business premises,
- rights to a detached house in a housing association,
- copyright or related property rights,
- licenses,
- rights specified in the Act of 30 June 2000 - Industrial Property Law,
- value being the equivalent of obtained knowledge-related information in the field of industrial, commercial, scientific or organizational (know-how),
- with an anticipated period of use longer than one year, used by the taxpayer for needs related to his business activity or given by him for use under a license agreement (sublicense), lease contract or a specific contract. In turn, the second act - Intellectual property law to intellectual property rights qualifies: patents, protection law for: utility model, trademark; the right to register from an industrial design.

An additional requirement that introduces tax law is the value of a given intellectual property right, which should be above PLN 10,000, which is related to the subsequent depreciation of this asset. In order to be able to amortise intellectual property rights, an enterprise must purchase them from another entity on the market. This is an obligatory condition that imposes law. Therefore, one cannot create such a right on his own and then depreciate it. After purchasing the listed rights, we must proceed to the correct determination of the initial value. At a value of less than PLN 10,000, taxpayers can make depreciation write-offs or one time in the month of putting into use an intangible asset or in the following month. Legal regulations provide depreciation deductions from the initial value of a given intellectual property right, from the first month following the month in which the given intangible asset was entered in the register. Thus, the taxpayer can choose the method of calculating amortization write-offs and their frequencies, eg monthly, quarterly, once a year. It is assumed that depreciation charges are made until the amount of depreciation write-offs is equated with their initial value. It should be emphasized that certain intellectual property rights, eg trademarks, patents, utility marks, even though they belong to entrepreneurs, their depreciation is possible in the case of obtaining legal protection of a given intellectual property right in the Patent Office of the Republic of Poland or the EU Patent Office. The depreciation period is described in detail in art. 16m paragraph 1 of the Corporate Income Tax Act, ie:

- from licenses (sublicenses) to computer programs and from copyrights - 24 months;
- from the license to display films and the broadcasting of radio and television programs - 24 months;
- from incurred costs of completed development works - 12 months;
- from other intangible assets - 60 months.

The mentioned provisions do not separately deal with intellectual property rights with a specific depreciation rate. Entrepreneurs most often take a rate of 20% per annum, booking depreciation write-offs for 60 months. This is the most advantageous solution, because faster deduction of intellectual property rights into the costs of the initial value of the intellectual property results in a lower income tax. Of course, an entrepreneur may extend the amortization period of intangible assets for any period of time. He must remember, however, that the amortization rate can only be changed from the beginning of the tax year.

#### **4 Rules for Determining Costs Due to Intellectual Property Rights**

The basic principle of tax law resulting from the adjustment is found in both laws on income tax, which provides that the costs borne by the taxpayer must have a cause - effect relationship. By transferring this to the land of intellectual property rights that are assets of a given entrepreneur, it is necessary to use them in the course of business. The mere fact of being in possession does not entitle the entity to include depreciation costs, e.g. of a trademark, patent, etc., to tax deductible costs. Since the taxpayer uses trademarks or other intangible assets, they should generate revenues. The legislator does not assume that they must appear obligatorily, however, they are desirable. It is worth noting that the possessed intangible assets must absolutely contribute to the appearance of revenues. There may be such a case where, for example. Entrepreneur from the confectionery industry will have depreciated and trademark, which identifies with quite other products eg. Furniture. If he acts as a producer and sells his products, he is identified in the market by a trademark that was created for these purposes. The Law on Industrial Property (Art. 120) says that a trademark any sign capable of being represented graphically, that such signs are capable of distinguishing the goods of one undertaking from those of other undertakings. Here stands the law of trademarks, words, designs, ornaments, combinations of colours, the shape of goods or their packaging, as well as melodies or other acoustic signals. The presented definition shows the variety of trademark characters. Each entity will therefore be entitled to use the trademark and then recognize their depreciation costs, if they will be used in the course of business. The law does not prohibit the possession of many trademarks, so the trader will be able to purchase and then register several protection rights for trademarks.

The first tax expense, which is undoubtedly related to the intellectual property right in the form of a trademark, are expenses related to its registration. Assistance in this area is provided by patent attorneys who relieve trademark owners on many matters related to registration. For example, an entity registering a given intellectual property right must

include the following costs associated with the registration. For example, with a trademark, these are:

- activities carried out by the Patent Attorney at the request of the trademark registration company;
- for preparing a list of goods for filing a trademark for each class;
- for preparing a description of the mark;
- for developing the regulations of the trademark;
- for examining the registration capacity of the mark.

After the positive approval of the application for registration by the registration authority, a protective decision is issued for a given intellectual property right, eg a trademark for a period of 10 years. The applicant applying for registration pays a fee, which is also a tax-deductible cost. After obtaining a protection right, eg for a trademark, an entrepreneur may start to amortize it according to the principles provided for in tax law. Upon registration of the intellectual property right, it is deemed to have been produced. Intellectual property law, which is, among others the trade mark must be priced by an appraiser before entering the balance sheet. This is a condition to make tax depreciation write-offs. When determining the value of a given trademark, the following methods are used:

- cost methods (reproduction cost and replacement cost),
- market methods (based on a comparable valuation, economic value of the product or market value of the enterprise),
- income methods (the profit multiplier method, discounted cash flows) cash, license fees),
- methods based on the valuation of real options related to the brand [9].

Intellectual property rights in order to be depreciated, first must be recorded in the records of intangible assets. This state confirms that they are controlled by a company that can freely dispose them through the right of ownership.

Fulfilling these conditions with respect to intangible assets is a condition that the depreciation costs can be directly recognized in the settlement of the financial result.

The table below presents an example of simulation of the calculation of the cost of depreciation of a trademark and its impact on the financial result in the tax treatment of the enterprise.

**Table 1.** Simulation of the calculation of the financial result including the amortization of the trademark.

Specification	The company's financial results
Value of the trademark	1.200.000,00 zł
The rate of annual depreciation	20 %
The value of annual depreciation	240.000,00 zł
Hypothetical savings due to non-payment of income tax	Tax rate 19 % tax 45.600,00 zł

The presented calculations show that the costs of depreciation of a trademark constitute tens of thousands of zlotys. In most units, the management takes what amortization rate will be applied. Maximum is 20%, however, it is possible to apply a lower rate. However, this must start from the new tax year. In the event when an enterprise does not achieve high revenues, it is reasonable to reduce the depreciation rate so that the write-off of the initial value of an intangible asset will be postponed for a period when the entity will generate large revenues. Then, it will result in lower income tax payments. An entrepreneur may have several trademarks. If all of them will be used as part of a business, it is effective in reducing your taxable income.

## 5 Conclusions

The presented subject matter of selected intangible assets is very important from the point of view of maximizing financial benefits. It can certainly be said that intellectual property rights provide a large field for action in reducing the tax burden. Therefore, it has a big impact on shaping the financial result of the entity. However, in order to do this, it is necessary to care about the proper determination of tax costs in terms of depreciation. Only reliable and defective presentation of the costs of amortization of intellectual property rights will allow one to reduce tax without any problems. In summary, it can be said that proper management of the operating costs of the intangible assets in question is a good way to optimize taxes.

## References

1. Hussey, R.: A Dictionary of Accounting, Oxford University Press, New York (1995).
2. Chareonsuk, Ch., Chansa-ngave,j Ch.: Intangible Asset Management Framework: An Empirical Evidence, Industrial Management & Data Systems 110(7), 1094–1112 (2010), DOI: 10.1108/02635571011069121.
3. Jaruga, A., Fijałkowska, J.: Rachunkowość i zarządzanie kapitałem intelektualnym, Ośrodek Doradztwa i Doskonalenia Kadr, Gdańsk (2002)

4. Kotyla, C.: Aktywa niematerialne i ich ujmowanie w sprawozdawczości finansowej, Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach, nr 268/2016, 120–121 (2016)
5. Michalczuk, G., Aktywa niematerialne jako generatory wartości w spółkach notowanych na GPW, [http://jmf.wzr.pl/pim/2012\\_4\\_2\\_4.pdf](http://jmf.wzr.pl/pim/2012_4_2_4.pdf), last accessed czerwiec 2018, (2012).
6. Stańczyk-Hugiet, E., Stańczyk, S.: Kultura organizacyjna – strategiczny zasób organizacji przyszłości, In: Management Forum 2020, pp. 13, Wydawnictwo Akademii Ekonomicznej we Wrocławiu, Wrocław (2002).
7. Porozumienie w sprawie handlowych aspektów własności intelektualnej Dziennik Urzędowy UE L 336, 23/12/1994 P. 0214 – 0233.
8. Urbanek, G.: Zarządzanie Marką, pp. 20, PWE, Warszawa, (2002).
9. Urbanek, G.: (2008), Wycena aktywów niematerialnych przedsiębiorstw, pp. 158, PWE, Warszawa (2002).
10. Ustawa z dnia 30 czerwca 2000 r. Prawo własności przemysłowej (tekst jednolity z 2017 r. poz. 776)
11. Ustawa z 4 lutego 1994 r. o prawie autorskim i prawach pokrewnych (tekst jednolity z 2017 r., poz. 880)
12. Żak, D.: Prawna ochrona własności intelektualnej w Internecie, In: Żak, D. (eds.) Własność intelektualna w Internecie, pp. 15–16, Towarzystwo Naukowe KUL, Katolicki Uniwersytet Lubelski, (2017)

# **Barriers to the Development of Consumption Sustainability: the Consumers' Perspective on the Food Markets**

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**Abstract.** This publication aims to present barriers to the development of sustainable food consumption from the perspective of consumers. The purpose of the research was to use the results of own research and other authors, supplemented with the knowledge and experience of the author, using the method of desk research. The information gathered by the author (based on own research) on the risks resulting from the implementation of a sustainable consumption model allowed to identify barriers to the development of sustainable consumption from the perspective of consumers and to categorise them. The study shows that the development of sustainable consumption is associated with a number of barriers, such as 1) economic barriers (higher prices, supply-related costs), 2) time barriers (higher time expenditure for balancing the consumption model in relation to conventional consumption, in conjunction with the preparation of meals on the farm domestic and self-supply issues and as a result of searching for appropriate products), 3) organisational barriers (need to involve new rules, self-control), 4) social barriers (dissatisfaction of the household, new fashion, refusing pleasure), 5) barriers resulting from market imperfections (difficult access to products, narrow range, insufficient information). The results obtained are useful for government institutions, production and trade companies operating in the agri-food sector as well as pro-environmental and prosocial organisations that, knowing what constitutes a barrier to balancing consumption, these forms of behaviour, can design strategies to achieve positive results in areas related to the environment, economy and society.

**Keywords:** Consumption-Sustainability, Consumers', Barriers, Development.

## **1 Introduction**

The interest in the issue of sustainable consumption has been observed at the beginning of the 1990s on the international arena and resulted from the concept of sustainable development [19, 20]. Domestic and international research on understanding and defining sustainable consumption emphasises the following: 1) stressing that it takes different positions regarding the extent to which sustainable consumption refers to consumerism, lifestyle and consumer behaviour, thereby pointing out that consumer



activity and consumer behaviour are an area of interest, 2) focusing on production processes and consumer products, stressing that balancing consumption is mainly achieved through more efficient production of sustainable products, and 3) consciously combining these issues [6, 11, 12, 14, 17, 18, 21, 22].

The concept of sustainable consumption and production assumes that the development of societies is based on the principles of justice in the social dimension, respect for existing resources, and care for future generations. This idea collides with the reality of the modern world, within which the diversity of the standard of living is promoted by increasing consumption and production, thereby bringing adverse effects on the environment. The market with a significant impact on the environment is among others the food market, which is characterised by market imbalance, excess food production, uneven food consumption (i.e., with about 20% of the population realising food expenses below the minimum subsistence income) in Poland. The level of expenditure on food, alcoholic beverages and tobacco in total household expenses was just over 24% in 2017 in Poland and is characterised by low dynamics [8].

The agri-food sector in Poland offers consumers goods produced by various industries to meet their current and future needs and to provide satisfaction to consumers. The consumption model in Poland is becoming to assemble the consumption model of Western countries. Consumerism is developing intensively and, in opposition to it, alternative directions of changes in consumption, among others rationalisation of consumption, sharing, de-consumption, eco-consumption, thereby moving towards the sustainable consumption, emerging under the influence of globalisation and being a consequence of its dynamic socio-economic changes [6, 21, 22].

Sustainable consumption is described as a favourable and versatile trend. Earlier results of the author's research indicate, however, that many consumers still identify sustainable consumption with greening, which narrows the concept. Often, the awareness of this concept is not related to consumer behaviours, which are in line with the trend of sustainable food consumption. This element is the result of, among others, economic coercion and still strong consumerism. The perspectives of balancing consumption depend on the ability to raise the level of innovation of consumers, as well as enterprises, scientific and governmental institutions [15]. Creating an environment conducive to the creation and development of innovative behaviours aimed at balancing consumption requires bringing together academic communities, industry, government and civil society organisations to jointly design interventions that facilitate progress towards a more sustainable future. In the context of this issue, it is essential to know the opportunities and threats and the barriers to balancing consumption. This issue can, therefore, be considered from different perspectives:

- Consumers: e.g. the degree of acceptance of the sustainable consumption model,
- Enterprises: e.g. incentives to develop products and provide services aimed at implementing a sustainable consumption model,
- Local authorities and other entities of a regional or local nature: for example, ensuring sustainable consumption through products and services for the benefit of local and regional communities, and

- Countries: for example, economic policy tools that ensure the effective functioning of the sphere of consumption and production.

This publication aims to present barriers to the development of sustainable food consumption from the perspective of consumers. This study is a theoretical introduction, based on a review of the subject literature and presents the result of the author's analysis.

## 2 Data and Methods

The purpose of the research was to use the results of own research and other authors, supplemented with the knowledge and experience of the author, using the method of desk research. Primary materials came from a survey. As part of our own research, primary materials were used from a questionnaire study carried out using direct interview technique in the Department of Economics and Economic Policy in Agribusiness at the Poznań University of Life Sciences, in 2017. The survey was carried out among the citizens of Greater Poland. Respondents were selected by quota and purposive sampling method. This approach enabled to build the sample structure so that it could correspond with the structure of citizens in Greater Poland per age and sex. There were 433 interviews conducted in total.

Out of all age thresholds, 18.54% of them were women, and 46% were men. The interview was representative as it encompassed similar numbers of respondents of both sexes concerning latest demographic data of the Polish Central Statistical Office (pol. Główny Urząd Statystyczny), that show that the population of women in Poland is higher compared to men and amounts to 51.50%. Most of them were respondents from the age group 35-44 (over 19%, with 52% of them being women and 48% being men). The next ones, regarding the number, were three age groups: 18-24, 25-44 and 55-64, each of them having ca. 16.40% share in the surveyed group. The group „65 and more” was slightly smaller (15.90%). In the sex structure, the most distinguishing was the first age bracket– 59% of women and 41% of men. These differences did not have any negative impact on the results of the conducted surveys. They also did not vary from other commonly available surveys. Both for women and men, the average age amounted to 44 years with some minor differences. The survey was conducted in 74 locations; the largest group were citizens of Poznań (43%). People with higher education prevailed (33%). 45% of respondents claimed they had an average standard of living in that they can afford every-day living expenses, but they have to save money for more expensive items.

The study was one of many studies leading to a deeper understanding of the issue under consideration in the related project and analysis of consumer behaviour in the context of sustainable consumption. For the purpose of preparing the presented publication, the answer to questions regarding consumer awareness on the concept of sustainable consumption and threats related to the adoption of such a consumption model within own households was used, among others with the following question: "How can you describe what the concept of sustainable food consumption means?", "What do you think are the risks of adopting sustainable consumption in your

household?". Respondents identified the main risks of sustainable consumption. Then, the author identified barriers to sustainable consumption on the basis of the material collected.

There were open- and closed-ended questions. Closed-ended questions are used when a researcher wants to diagnose respondents' attitudes to selected categories (units). Open-ended questions enable the respondent's freedom of expression. The method used for the examination of the research question was a content analysis used for surveying, e.g., press articles, posts on Internet forums, etc. An important element of content analysis is the creation of the system of statement categorisation (so-called key), which is used for assigning respondents' statements into a suitable category. This analysis enabled the quantitative analysis of an open-ended question. The key was created using a new technique, in which categories are created only from collected empirical data created by respondents' spontaneous statements, and the final key contained the set of categories. The unit of analysis was a respondent's statement that contained an answer to the question mentioned above. For example, in one statement a respondent could disclose more than one risk caused by changing into sustainable consumption in a household (question with multiple answers). Subsequently, the answers were subject to a factual analysis using the elements of a content analysis developed by Berelson [1].

### **3 Results and Discussion**

Based on the collected research material and knowledge about the market, barriers to balancing the model of food consumption from the consumers' perspective have been formulated (Table 1). As part of the research, respondents were asked to specify the main threats related to the implementation of a sustainable consumption model and based on the collected material, barriers to the course were identified, the possibility of balancing consumption within households, in extreme cases even preventing them. These barriers are an expression of the real problems of many members of society.

Economic barriers - related to the source of financial power of the household and its level, as well as the changeability of socio-economic conditions. Income and finances of households are the most important economic factors affecting the quantity and quality of food consumed. Occurrence of increased ("too high") costs of consumption, due to its balancing (e.g., determined by lower earnings of persons with a lower level of education). High costs of such consumption as a result of searching for, purchasing and consuming better products of higher quality (including health-related products, organic food), where households characterised by a better financial situation show a higher tendency to introduce such changes. Such products should exceed common goods regarding quality, functionality, user attributes and innovation. New solutions often interfere with earlier, developed ways of planning and organising supply processes, entailing incurring higher costs resulting from the method of supply. In this context, lack of willingness of consumers to incur higher costs for purchasing products from sustainable production should be emphasised.

**Table 1.** Barriers to the development of sustainable consumption from the perspective of consumers and their categorisation.

Economic barriers	Time barriers	Organisational barriers	Social barriers	Barriers resulting from market imperfections
Higher prices	Higher expenditure of time for balancing the consumption model in relation to conventional consumption	The need to be involved in the implementation of new rules	Unhappy family members	Difficult access to products
Costs related to procurement	Higher time expenditure as a result of searching for appropriate products	The necessity for self-control	New fashion	Narrow assortment
	Higher expenditure of time in connection with the preparation of meals within the household and the issue of self-help		Refusing of pleasure	Insufficient information

Time barrier – is related to the need to incur higher time expenditure in shaping consumption (e.g., at the expense of free time). Following the idea of balancing of consumption, the consumer prepares and consumes meals composed from relevant products, with high participation of own work, in the right place and time. This approach generates the occurrence of higher time expenditure for the balancing of the consumption vis-a-vis the traditional consumption. It may require a reorganisation of activities of its members. Due to the time-consuming nature of such processes, consumers may not want to get involved (for example, the time (cost) of recognition, related to the study of various markets to determine the scope of possibilities that the buyer will be able to include for consideration). Taking more time out of searching for the right products may require from consumers the identification of essential features of these products (including type, composition, authenticity, functionality, durability, ecological or natural character). The method of satisfying the needs of consumers (prevailing food freedom) within the household is continually changing (mainly qualitatively) that would also have to be included in the process of balancing consumption. In turn, higher expenditure of time in connection with the preparation of meals within the household and the issue of self-supply may result from the use of goods manufactured by the consumer for his own needs (as a consumption excluding the market). Using the means of consumption supplemented in the household as part of its production and service activities require more time than its members have at their disposal. Location in the city (and not in the countryside) may additionally affect the relatively low share of self-supply in the household.

Organisational barriers - occur for consumers due to the need to be involved in the implementation of new rules, including related to meeting environmental, ethical,

ecological standards, care for the natural environment, etc. Consumers need to consider how to increase the share of products from organic production and how to proceed according to the rules and methods of waste recycling. In addition, they have to search for information, track messages on the Internet, television, buy only those dishes that will be consumed in the household. The necessity of self-control, among others, concerning the method of making purchases (e.g. making purchases based on and shopping list), choosing the selection, using them, the way of getting rid of, wastage are essential barriers to support the idea of sustainable food consumption.

Social barriers – relate to the appearance of dissatisfaction of household members to undertake new, additional activities for the benefit of the household and the need to balance consumption. In this regard, there is a need to change personal habits and those of family members. As a consequence, consumers may not achieve the tangible effects of balancing consumption within the household due to the lack of commitment of all members. Lack of social ability (balancing consumption) associated with greater self-control and rupture (change) of previous habits is associated with conscious refusing of pleasure (following the principle of "here and now" or waiting for future effects). By taking the form of a microtrend, it can exhibit opposite, abolishing, and synergistic tendencies towards the desired consumption model. An important issue is the direction and method of its development (e.g., that waste phenomenon not grow in the sphere of consumption). Sustainable food consumption includes two critical aspects: 1) the need to pay attention to insufficient food consumption, and 2) the growing consumer group and their very high level of consumption. Actions for a high quality of life and balancing the consumption of food are the desired direction of change. However, the required change in society must be based on increasing the knowledge of consumers and other market participants about sustainable food consumption.

Therefore, one should look for solutions for mitigating barriers and developing practices and behaviours that help preserve the natural resources we manage. Based on the available literature, the author has formulated barriers related to the balancing of consumption, including the financial situation, in the scope of specifying the concept of "sustainable consumption", seasonality of production and products, the lack of knowledge and awareness of consumers about sustainable products. The financial barrier associated with a higher subjective assessment of the financial situation is conducive to the interest in sustainable consumption. Better financial situation increases consumers' willingness to spend more money on organic products and local food. Positive consumer opinions on the financial situation are critical, as consumers may be more likely to buy premium food products in the future [11].

Solutions should be sought for mitigating barriers and developing practices and behaviours that allow us to preserve the resources we manage. The review of the bibliography related to the issue of barriers to consumption balance entitles us to state that the authors attempt to explain the incoherence observed in consumer behaviour in the area of sustainable consumption due to threats to its development. They propose a conceptual framework that takes into account different attitudes and barriers and explains how they are related to sustainable consumption behaviour. For example, among the barriers affecting decision-making regarding sustainable consumption, the following are mentioned: personal, behavioural and socio-cultural [4, 5, 10].

The subject of consideration is also the review of sustainable consumption as a subject of policy and research, drawing attention to the challenges associated with the development of communication campaigns that will motivate a wide range of society to engage in a more sustainable lifestyle [12, 13].

The size of the concept of sustainable consumption as well as the complexity of the phenomenon itself, make researchers also identify other barriers related to the balancing of consumption. For example, by including barriers relating to the financial situation, how to specify the concept of "sustainable consumption", the seasonal nature of production and products, lack of knowledge and awareness of consumers about sustainable products, lack of acceptance of sustainable consumption [2, 3, 6, 9, 11, 12, 13, 17, 23].

The process of balancing consumption requires effort to improve efficiency, change consumption patterns and reduce consumption. Both domestic and foreign surveys confirm that these difficulties result from increased consumption, environmental impact, demonstrative effects of developed countries and consumerism [12].

#### **4 Conclusion**

The results of research on the development of sustainable consumption from the perspective of consumers allow formulating several conclusions. Consumers in their environment observe the existence of barriers to the balancing of the model of food consumption within households. From the consumers' perspective, the following barriers limit the development of the sustainable food consumption model:

- Economic barriers - higher prices, costs related to supplies;
- Time barriers - higher expenditure of time in connection with the preparation of meals within the household and the issue of self-supply, higher expenditure of time as a result of searching for appropriate products;
- Organisational barriers - the need to engage in the implementation of new rules, the need for self-control;
- Social barriers - dissatisfaction of household members, new fashion, refusing pleasure;
- Barriers resulting from market imperfections - restricted access to products, narrow range, and insufficient information.

These results are useful for governmental institutions, production and trade companies operating in the agri-food sector as well as pro-environmental and prosocial organisations that, knowing what constitutes a barrier to balancing consumption, these forms of behaviour, can design strategies to achieve positive results in areas related to the environment, economy and society.

The material presented above is a fragment of the author's broader research, seeking to evaluate the direction of changes in consumption, and is a research challenge raising a significant issue within the framework of economic and social sciences. Consumers in their environment perceive the existence of barriers related to the adoption of a sustainable consumption model while displaying a different level of knowledge on this

topic. As part of the article (due to the limited number of pages), no analysis was provided to identify the most critical barriers from the consumers' perspective. This element requires additional verification of the collected material taking into account the number of indications, assessment of the importance of barriers and will contribute to the next publication.

## References

1. Berelson, B.: Content analysis in communication research. The Free, New York (1952).
2. Binet, F., Coste-Manière, I., Decombes, C., Grasselli, Y., Ouedermi, D., Ramchandani, M.: Fast Fashion and Sustainable Consumption. In: Muthu S. (eds.) Fast Fashion, Fashion Brands and Sustainable Consumption, Textile Science and Clothing Technology. Springer, Singapore, pp. 19-35 (2019). DOI: 10.1007/978-981-13-1268-7\_2.
3. Byłok, F.: Nowa moralność konsumentów we współczesnym świecie. *Acta Universitatis Lodzensis. Folia Sociologica*, 48, 111-116 (2014).
4. Dibb, S.: Socio-economic barriers and opportunities for sustainable diets in Europe. Commissioned report. Sustainable Food Consultant Date (2013).
5. Figueroa-García, E., García-Machado, J., Pérez-Bustamante Yábar D.: Modeling the Social Factors That Determine Sustainable Consumption Behavior in the Community of Madrid. *Sustainability* 10(8), 2811 (2018). DOI:10.3390/su10082811.
6. Goryńska-Goldmann, E., Adamczyk, G., Gazdecki, M.: Awareness of sustainable consumption and its implications for the selection of food products. *Journal of Agribusiness and Rural Development* 3(41), pp. 301-308 (2016). DOI: 10.17306/JARD.2016.57.
7. Górską-Warsewicz, H., Świątkowska, M., Krajewski, K.: Marketing żywności. Wydawnictwo Wolters Kluwer S.A., Warszawa (2013).
8. <http://stat.gov.pl/index.php>, URL, last accessed 2018/10/31.
9. Jaros, B.: Bariery i pozytywne tendencje w rozwoju zrównoważonej konsumpcji w Polsce. In: Demianowicz, J. (eds.) *Ekonomia i środowisko*, nr 2(57), pp. 24-36 (2016).
10. Joshi, Y., Rahman Z.: Determinants of sustainable consumption behavior: Review and conceptual framework, pp. 239-262 (2017). DOI: 10.4018/978-1-5225-2662-9.ch011.
11. Kiełczewski, D.: Konsumpcja a perspektywy zrównoważonego rozwoju. Wydawnictwo Uniwersytetu w Białymstoku, Białystok (2008).
12. Liu, W., Oosterveerc, P., Spaargarenc G.: Promoting sustainable consumption in China: a conceptual framework and research review. *Journal of Cleaner Production*, 134, Part A, pp. 13-21 (2016). DOI: 10.1016/j.jclepro.2015.10.124.
13. Lorek, S., Vadovics, E. (eds.): Sustainable Consumption and Social Justice in a Constrained World. Proceedings of the SCORAI Europe Budapest Workshop, Sustainable Consumption Transitions Series, Issue 6 (2016).
14. Mancini, P., Marchini, A., Simeone, M.: Which are the sustainable attributes affecting the real consumption behaviour? Consumer understanding and choices. *British Food Journal*, 119(8), pp. 1839-1853 (2017). DOI: 10.1108/BFJ-11-2016-0574.
15. Marek, E., Jerzyk, E.: Libertariański paternalizm, zielony marketing i neuronauka jako filary zrównoważonego rozwoju. *Handel Wewnętrzny*, vol. 3, pp. 10-21 (2018).
16. Reisch, L. A., Bietz, S.: Communicating Sustainable Consumption. In: Godemann, J., Michelsen, G. (eds.) *Sustainability Communication*. Springer, Dordrecht (2011). DOI: 10.1007/978-94-007-1697-1\_13.

17. Thøgersen, J.: Knowledge barriers to sustainable consumption. In: Bone, P., France, K., Wiener, J. (eds). *Proceedings Marketing and Public Policy*, pp. 29-39. American Marketing Association (2000).
18. Ulph, A., Southerton, D.: *Sustainable Consumption. Multi-disciplinary Perspectives*, Oxford Scholarship Online (2014). DOI: 10.1093/acprof:oso/9780199679355.001.0001.
19. Wang, Y., Xiang, D., Yang, ZY., Ma, S.: Unraveling customer sustainable consumption behaviors in sharing economy. In: *A socio-economic approach based on social exchange theory*, *Journal of Cleaner Production* 208, pp. 869-879. Published by Elsevier Ltd. (2019).
20. WCED, *Our Common Future, The Brundtland Report*, Oxford University Press, Oxford (1987).
21. Zalega, T.: Zrównoważony rozwój a zrównoważona konsumpcja – wybrane aspekty. *Konsumpcja i Rozwój*, 4(13), pp. 14-26. IBRKK, Warszawa (2015).
22. Zalega, T.: Nowe trendy konsumenckie jako przejaw innowacyjnych zachowań współczesnych konsumentów. *Nierówności Społeczne a Wzrost Gospodarczy*, nr 46 (2), pp. 3-21. Uniwersytet Rzeszowski (2016).
23. Zaremba-Warnke, S.: Marketing zrównoważony vs. niezrównoważona konsumpcja. In: *Studia Ekonomiczne. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach*, 255, pp. 92-101 (2016).



## Industry 4.0 Market in Poland from the International Perspective

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**Abstract.** Digitalization and smart technology application have focused the attention and consolidated the efforts of research schemes, political agendas and business strategies worldwide. The European Union is particularly interested in the deployment of its smart reindustrialization strategy, which is in line with the Industry 4.0 concept, promoted by German government and business entities. The actual impact of the industrial digital transformation is not yet envisaged; however undoubtedly, Poland will be affected by this economic phenomenon. Its competitive advantage on the international market, resulting from low labour costs and central European location, will continue to decrease as digitised, automated and connected industries are less sensitive to cost and geographical limitations. The present study is aimed to assess the level of familiarity with Industry 4.0 concept within Polish industrial sector as well as the potential demand of the domestic market for digital solutions. The paper will also discuss the ability of Polish economy to participate in smart reindustrialisation, which has been deployed and prioritized in the European agenda.

**Keywords:** Industry 4.0, Smart Reindustrialization, Digital Transformation.

### 1 Introduction

Digitalization and information technology advancements have taken over the attention of decision makers and entrepreneurs worldwide. Innovation and research activities are focused on creating ever smarter solutions and systems to be broadly applied in our homes, regions and economies. Schumpeter argued that any person seeking profit must innovate; however, the macroeconomic effects of a basic innovation tend to remain unnoticeable. In terms of economic growth, the diffusion of new and disruptive solutions is far more important. It is when the imitators realize that the new product or process could bring significant profits and advantages, and thus begin to invest heavily in them [17]. Yet, transformative innovations are only possible if a critical mass of social actors is ready to commit to them in an early stage, before the outcome seems inevitable [11].

The spread of Industry 4.0, often called the forth industrial revolution, has exemplified the above argument. It was introduced in 2011 at Hannover Messe Industrial Fair and, in a fairly short period, developed from an abstract concept, which denoted industrial digitalization, into a tangible reality with many application projects

in progress. It became a strategic initiative promoted and financed by the German government within the scope of the High Tech 2020 Strategy with the aim to consolidate the country's technological leadership in mechanical engineering on the global market [6]. The European Union, together with its member states, also recognized the potential of digitizing and developing smart industry as a tool for reindustrializing the European economy. At present, 68% of EU national governments, including Poland, have put in place domestic policies for the digitization of industry. However, Polish economy is perceived to generate low innovation outputs, underperform in digital skills of employees and lack digital infrastructure, thus its future in the smart economy framework is uncertain [5].

## **2 Purpose of the Research**

Industry 4.0 is based on the robotization and automation of production and supply chains using advanced IT programs and the Internet of Things, enabling independent communication between machines and real-time data processing. It is founded on nine technology pillars, which are already applicable on the shop-floor and in business practice. They include: Internet of Things, artificial intelligence, robotics and automated machinery, big data and data analytics, mobile services, 3D printing, cloud technologies, virtual and augmented reality and cybersecurity solutions. In this concept the technology is merely a tool to realize a far more important idea of interoperability and interconnection of products and services, value chains, as well as company's business models. Industry 4.0 is expected to transform production from isolated and independent cells to fully integrated, automated and optimized process flow, leading to great improvements in the overall productivity, efficiency and sustainability of business operations [2]. Its key characteristics include operating in highly flexible, networked and autonomous production environments, early-stage engagement of end users and business partners into the design and value-creation processes, and, as a result, providing extensively personalized and connected products, which share data on consumer satisfaction in real-time. The actual impact of the industrial digital transformation is not yet envisaged; however, it is forecasted that the global market for Industry 4.0 solutions will reach 152.31 billion USD in 2022, whereas it accounted for 66.67 billion USD in 2016 [13]. Germany remained at the forefront of Industry 4.0 integration, which is demonstrated by the market's annual turnover of 5.9 billion EUR in 2017, an increase by 20% compared to 2016 [8]. German enterprises declared they would invest approximately 3.3% of their annual revenue until 2020 in adopting advanced technologies [13].

Poland will be undoubtedly affected by this economic phenomenon. The country's competitive advantage on the international market, resulting from low labour costs and central European location, will continue to decrease as digitised, automated and connected industries are less sensitive to cost and geographical limitations. On the other hand, Poland suffering from the lack of interdisciplinary and digitally skilled workforce as well as innovation and investment capital, is facing the threat of becoming the Industry 4.0 outsider. Therefore, the present study is aimed to assess the level of

familiarity with Industry 4.0 concept within Polish industrial sector as well as the potential demand of the domestic market for digital solutions. The paper will also discuss the ability of Polish economy to participate in the smart reindustrialisation agenda deployed on the European level.

### 3 Research Methods and Organization

Research was conducted by means of diagnostics opinion poll method and survey technique. The study group consisted of thirty-one providers of Industry 4.0 solutions, who operate on the Polish market. They are representatives of companies that offer products and services related to the application of smart industry in business operations and were identified and approached by the author due to their active participation in the Industry 4.0 related events, discussions and media. The study was conducted between April and September 2018.

The majority of respondents (74%) represented foreign entities operating in Poland, and a significant number of them came from private and large businesses (45% and 42% respectively). Nevertheless, Polish and medium enterprises constituted ca. one third of the research population.

**Table 1.** Classification of enterprises represented by respondents.

What type of enterprise do you represent? (more than 1 answer could be selected)			
74%	Foreign	42%	Large
32%	Polish	26%	Medium
45%	Private	10%	Small
0%	Public	6%	Micro

Foreign enterprises were mostly originated in high-income and developed economies, primarily in Germany, followed by United States, Japan and Switzerland. The majority of respondents operated in automation and robotics industry (see Table 2), and almost a half of them were based in Warsaw. Moreover, 68% of respondents occupied C-level or middle managerial positions.

**Table 2.** Industries in which respondents operate.

Which industry does your company represent? (most popular indications)			
58%	Automation and robotics	13%	IT and analytical software
16%	Mechanical engineering	6%	Electrotechnics

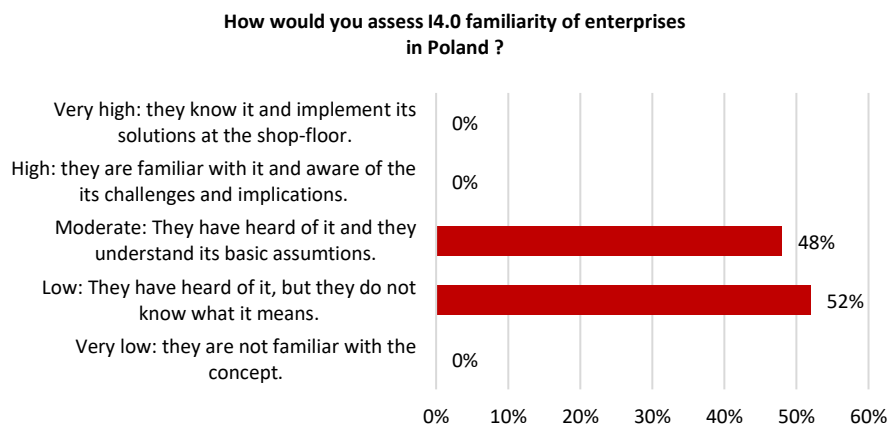
The aim of the study was to analyse the Industry 4.0. market in Poland from the supply-side perspective. Other available research to assess the market size and dynamics in Poland, conducted mainly by consulting companies and business entities [1, 14, 16],

targeted Industry 4.0 customers, thus enterprises in various industrial sectors. However, in the present study a different approach was adopted and Industry 4.0 suppliers were investigated in order to present their market overview and experience. The questionnaire survey comprised 12 questions and addressed the following problems:

- How familiar are companies in Poland with Industry 4.0?
- What is the structure of the Industry 4.0. market demand?
- Which industries are the end users for Industry 4.0 solutions in Poland?
- What is the demand level for Industry 4.0 in Poland and to what extent has it changed in the recent years?
- Which technologies are offered on the Polish market?
- How does the application of Industry 4.0 solutions affect the customer's business activity?
- Has the implementation cost changed in the recent years?
- Are the Industry 4.0 implementation projects monitored and do they influence the business performance of the customers?

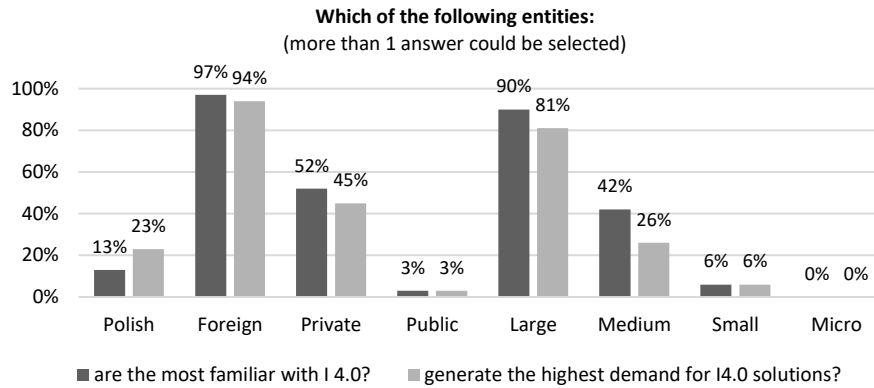
#### 4 Research Outcomes

The level of Industry 4.0 familiarity among enterprises in Poland was considered low or moderate. Study participants suggested that even though the domestic companies had heard of the concept, they did not know what it meant (52%) or they understood its basic assumptions (48%) (see Fig. 1).



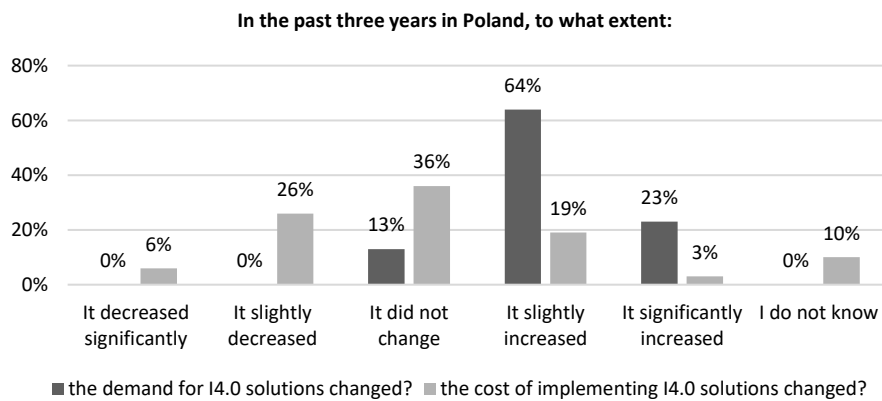
**Fig. 1.** Perceived level of Industry 4.0 familiarity of enterprises in Poland.

Foreign and large enterprises prevailed not only among respondents, but also on the demand side of the market. They were believed to be fully familiar with Industry 4.0 and generate the highest demand on the Polish market (respectively: 97% and 94% of foreign entities, and 90% and 81% of large enterprises – see Fig. 2).



**Fig. 2.** Familiarity with Industry 4.0 and market demand in Poland.

Only 13% of respondents admitted that Polish companies were fully aware of the industrial revolution, and 23% saw them generate the highest demand for digital technologies. Medium enterprises were perceived somewhat better, especially in terms of Industry 4.0 familiarity (42%). The overall level of demand for smart solutions in Poland was identified as low, which means that manufacturing companies are interested in Industry 4.0 technologies, but they are facing significant demand barriers. Nonetheless, almost 40% of study participants noticed prospects for market growth or stated that enterprises actually began to adopt Industry 4.0 in Poland. Moreover, as many as 87% declared that the demand for smart products and services slightly or significantly increased in the past three years, whereas the implementation cost remained more or less constant (see Fig. 3).



**Fig. 3.** Perceived change in the demand and implementation cost for Industry 4.0 solutions in Poland.

The highest demand for Industry 4.0 technologies was observed in automotive sector (93%), followed by mechanical engineering (45%), pharmaceutical (35%), aerospace

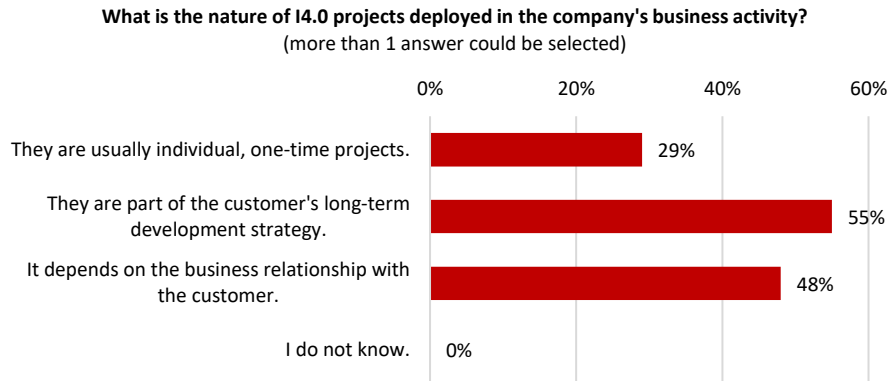
(33%), food processing (26%) and white goods (19%) industries, which significantly contribute to the Polish economy, but their market leaders are usually multinational and large enterprises. Thus, an interesting outcome was revealed with regards to the adoption of smart solutions by small and medium enterprises (SMEs). Despite the fact that 52% of study participants considered Polish SMEs to be incapable of implementing Industry 4.0 in the near future, as many as 42% believed that they would not only participate in the industrial revolution, but also improve their competitive position with this regard. Interestingly enough, 32% of respondents believed that whether or not Polish SMEs applied smart industrial solutions, it would have no effect on their market position. Such inconsistency in the assessment of Industry 4.0 impact on SMEs might result from the fact that they are lagging behind large companies in digital transformation; however, they are crucial to the supplier network, thus the gap must not be increased [18].

Among smart technologies offered to the market, process automation was mostly indicated. Other prevailing Industry 4.0 solutions were: Internet of Things, predictive maintenance, robotics, cloud computing, operating and information systems integration, and RFID communication (see Table 3).

**Table 3.** Industry 4.0 solutions offered by respondents to the Polish market.

<b>Which of the following 14.0 solutions does your company offer?</b> (more than 1 answer could be selected, most popular indications)			
74%	Process automation	42%	RFID
55%	Internet of Things	35%	Sensors
52%	Predictive maintenance	35%	Big data analytics
48%	Robotics	32%	Cybersecurity solutions
45%	Cloud computing	32%	Virtual and augmented reality
45%	OT and IT integration	16%	Additive manufacturing

Respondents were strongly convinced that smart technologies would make their customers achieve: higher efficiency (93%), cost reduction (90%), improved competitive position (77%), less equipment failures (68%), improved work safety (64%) and higher consumer satisfaction (48%). This is particularly interesting as 61% also declared to collect information from customers regarding the actual impact of Industry 4.0 projects deployed in their business activities. Moreover, 55% stated that such projects were part of the company's long-term development strategy, whereas one third admitted to implement projects not related to any internal strategy. At the same time, the nature of almost a half of Industry 4.0 completed projects depended on the business relationship between the customer and the supplier (see Fig. 4).



**Fig. 4.** Business character of Industry 4.0 projects deployed on the Polish market.

## 5 Discussion

Roland Berger, a German consulting company, performed analysis on the progress of national economies in Europe towards smart reindustrialisation. Their Industry 4.0 Readiness Index comprises two categories: “industrial excellence” (based on: production process sophistication, degree of automation, workforce readiness, innovation intensity) and “value network” (estimated upon: high value added, industry openness, innovation network, internet sophistication) and divides countries into four groups presented in Table 4:

**Table 4.** Industry 4.0 Readiness Index 2016 [15].

Group name	Characteristics	Countries
Frontrunners	Large industrial base, modernised, development-oriented business conditions and technologies;	Germany, Ireland, Finland, Sweden, Austria
Potentialists	Manufacturing industry in decline, possess capital and resources to implement Industry 4.0 solutions;	Belgium, Denmark, Netherlands, UK, France
Traditionalists	Thriving, sound industrial base, but traditional, not ready for digitalisation;	Czech Republic, Slovakia, Slovenia, Hungary, Lithuania
Hesitators	Lack of reliable industrial base, tend to suffer from fiscal problems, not able to transform their economy to digital;	Italy, Spain, Portugal, <b>Poland</b> , Estonia, Croatia, Bulgaria

Poland was classified as an economy resistant to industrial transformation, whereas its neighbouring countries in Central and Eastern Europe were ranked higher due to a better perception of their national manufacturing sectors and governance systems.

According to the Digital Transformation Scoreboard, used by the European Commission, as a monitoring tool for the Digitising European Industry (DEI) strategy adopted in 2016, the area of digitalization in Polish industrial sectors needs to be fully addressed as the country performs significantly below the EU-average [5]. Additionally, Poland has been repeatedly ranked the second worst country in terms of digital technology integration, a composite of the European Union's Digital Economy and Society Index (DESI), which measures the member states' progress in adopting smart solutions. Its distance to the ranking leaders: Denmark, Finland and Ireland, has increased as well [4].

Certainly, applying smart technologies is a challenge not only in emerging economies. According to IDC European Vertical Market Surveys, as many as 44% of German enterprises are qualified as "digital beginners" due to having integrated only four out of nine technological solutions, whereas 21% are perceived as "making digital progress". Fully digital organizations constitute less than 2% of the German business population, but the share is significantly higher among large enterprises (16%) [9]. In the European economy, the implementation of digital technologies strongly depends on the company size. SMEs significantly lag behind large enterprises in adopting data sharing IT infrastructure that include: ERP, cloud, CRM, RFID, supply chain management and social media [3].

The study on smart industry in Poland, conducted in 2016 by Siemens, proved that only one fourth of Polish managers in medium and large enterprises were familiar with the concept, yet many companies had already applied advanced manufacturing technologies in some areas of their business practice. Those were: process automation and robotics, big data and data mining, Internet of Things, cloud computing RFID and MEMS (sensors). Even though, large and multinational companies operating in Poland were more successful in the adoption of digital solutions than medium and Polish enterprises, an overall positive attitude towards the technological advancement of the Polish industrial sector was visible [16].

PwC outlined a similar finding in their report on challenges and opportunities that result from the industrial revolution. Polish respondents were particularly positive in the assessment of their digital progress so far (see Table 5).

**Table 5.** Companies that declare high level of digitalisation of their business activities [14].

Area of digitalisation	Poland	World
Vertical value chain	52%	41%
Horizontal value chain	46%	34%
Digital business models	36%	29%
Development of products and technique	53%	42%
Customer approach, distribution and marketing channels	47%	35%



In each of the indicated areas, Polish results were more optimistic than the world average. However, according to PwC, a large share of domestic companies continued to invest in automating individual cells on the shop-floor rather than creating cyber-physical systems within the Industry 4.0 framework. Thus, due to the historically poor condition of Polish industrial sector, respondents mistakenly perceived their recent development as manifestation of the smart revolution. The main barriers identified with regards to digital investments in Poland were high implementation costs, lack of digital strategy, as well as insufficient infrastructure, i.e. poor broadband coverage. However, study participants declared they would invest 7.7% of the company annual revenue until 2020 on digital solutions and expected a full return on investment within a two-year period [14].

Despite the optimistic approach of enterprises in Poland, Eurostat data on digital economy and society with regards to e-business leave no delusions to the fact that Polish companies lag behind the EU average and leading economies (see Table 6).

**Table 6.** E-business in Poland and the European Union in 2017 [7].

<b>Percent of enterprises which adopted:</b>	<b>Poland</b>	<b>EU average</b>	<b>EU leader</b>
ERP software to share information between different functional areas	26%	34%	54%
CRM software to capture, store and make available client information to other business functions	23%	32%	46%
RFID for aftersales product identification as part of the production and service delivery	3%	4%	16%
Processes automatically linked to those of their suppliers and/or customers	21%	18%	30%
Cloud computing services purchased on the Internet	10%	nd.	51%
Big data analytics from any data source	6%	10%	17%

In terms of e-business, Poland is outperforming only in supply chain management by means of the automation of processes to integrate with customers and suppliers. In all other aspects, related to integration of internal processes, cloud computing services and big data analytics, domestic enterprises remain below the EU average and perform significantly lower than the leading member states. Similarly, in terms of robot population density, the world's average in 2016, estimated at 74 units per 10k inhabitants, doubled the robotization level in Poland (32 units), while in Germany it accounted for 309 units [12].

## 6 Conclusions

The industrial digital transformation will determine the position of the Polish economy in the worldwide production networks and value chains. Despite the fact that domestic companies present a certain level of optimism with regards to their technological advancement and capacity, European statistical data and indicators suggest that Polish economy is lagging behind other member states in terms of digital performance. Reports published on Industry 4.0 and its market perspectives were focused on a self-assessment of medium and large enterprises which presented an extremely positive approach to business digital transformation and declared high level of advancement in integrating smart technologies. Nevertheless, research outcomes, described in the present article, confirmed that Polish companies are not fully familiar with the Industry 4.0 concept, even though they begin to invest in its adoption.

Industry 4.0 market in Poland is immature and its development is dominated and driven by multinational and large enterprises in the following industrial sectors: automotive, mechanical engineering, pharmaceutical, aerospace, food processing and white goods. Foreign entities also prevail on the supply side and they operate mainly in the field of process automation and robotics; however, they offer a full scope of Industry 4.0 products and services to the Polish customers. Despite the fact that industrial SMEs are perceived to lack the capability to adopt digital transformation in the near future, it is also believed that it would leverage their competitive market position. The demand for Industry 4.0 in Poland is growing, although companies face investment barriers. Moreover, the implementation cost, which has not changed significantly in the recent years, could become an enabler for small and medium manufacturing companies to invest in digital transformation.

Industry 4.0 is believed to bring significant benefits in the field of: efficiency improvement, cost reduction, competitive position, failure predictivity, work safety and consumer satisfaction. Importantly enough, the majority of projects implemented within smart industry framework were due to the company's long-term development strategy. Moreover, in accordance to Industry 4.0 principles, the majority of projects do not end up solely with technology integration, but they continue to provide data to the supply side on their actual impact on the company's business performance.

## References

1. Astor: Przemysł 4.0 rewolucja już tu jest. Co o niej wiesz?, [goo.gl/Bh7Th3](https://goo.gl/Bh7Th3), last accessed 2018/10/27.
2. Boston Consulting Group: Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries, [goo.gl/X5Ayns](https://goo.gl/X5Ayns), last accessed 2018/10/27.
3. European Commission: DESI Report 2018 – Integration of Digital Technology, <https://goo.gl/t7E1wj>, last accessed 2018/10/27.
4. European Commission: Digital Economy and Society Index, <https://digital-agenda-data.eu/datasets/desi/visualizations>, last accessed 2018/10/27.
5. European Commission: EU businesses go digital: Opportunities, outcomes and uptake. Digital Transformation Scoreboard, <https://ec.europa.eu/growth/tools->

- databases/dem/monitor/sites/default/files/Digital%20Transformation%20Scoreboard%202018\_0.pdf, last accessed 2018/10/27.
6. European Commission: Germany: Industry 4.0. Digital Transformation Monitor, <https://goo.gl/SYiuYv>, last accessed 2018/10/27.
  7. Eurostat, <https://ec.europa.eu/eurostat/data/database>, last accessed 2018/10/27.
  8. Germany Trade & Invest: Industrie 4.0 Germany Market Report and Outlook, <https://goo.gl/Zhnt8X>, last accessed 2018/10/27.
  9. Götz, M., Gracel, J.: The Fourth-Generation Industry (Industry 4.0) – challenges to research in the international context. *Vistula Scientific Quarterly* 1(51), 217-235 (2017).
  10. Industry 4.0 Market worth 152.31 Billion USD by 2022, <https://www.marketsandmarkets.com/PressReleases/industry-4.asp>, last accessed: 2018/11/24.
  11. Muscio, A., Ciffolilli, A.: Industry 4.0: national and regional comparative advantages in key enabling technologies. *European Planning Studies* 26(12), 2323-2343 (2018). DOI: 10.1080/09654313.2018.1529145.
  12. Robot density rises globally - International Federation of Robotics, <https://ifr.org/ifr-press-releases/news/robot-density-rises-globally>, last accessed 2018/10/27.
  13. PwC: Industry 4.0: Opportunities and challenges of the industrial internet, <https://www.pwc.nl/en/assets/documents/pwc-industrie-4-0.pdf>, last accessed: 2018/09/09.
  14. PwC: Przemysł 4.0, czyli wyzwania współczesnej produkcji, <https://www.pwc.pl/pl/pdf/przemysl-4-0-raport.pdf>, last accessed 2018/10/27.
  15. Roland Berger: Think Act: Industry 4.0 The new industrial revolution How Europe will succeed, [http://www.iberglobal.com/files/Roland\\_Berger\\_Industry.pdf](http://www.iberglobal.com/files/Roland_Berger_Industry.pdf), last accessed: 2018/10/27.
  16. Siemens: Smart Industry Polska 2016, <https://publikacje.siemens-info.com/pdf/123/Raport%20Smart%20Industry%20Polska%202016.pdf>, last accessed: 2018/10/27.
  17. Śledzik, K.: Schumpeter's view on innovation and entrepreneurship. *Management Trends in Theory and Practice* 1(51), 89–95 (2013). DOI: 10.2139/ssrn.2257783.
  18. Sommer, L.: Industrial revolution - industry 4.0: Are German manufacturing SMEs the first victims of this revolution?. *Journal of Industrial Engineering and Management* 8(5), 1512–1532 (2015). DOI: 10.3926/jiem.1470.

## Comparison of Current Business Environment in the Czech Republic and Poland

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**Abstract.** The paper assesses the current business conditions that the World Bank assesses annually. The data obtained from this database are further analyzed in order to gain insight into similarities and differences of the business environment in selected economies with similar territorial, cultural, historical and political background, but completely different populations and sizes. Czech and Polish economies are evaluated according to 10 criteria selected from a very wide range of areas that clearly contribute to the quality of the business environment. The selection and subsequent evaluation of individual criteria are subject to highly qualified processing by experts in each of the 190 countries that are annually involved in the project. This contribution uses data from the November report called *Doing Business 2019, Training for Reform*. The data were assessed for the period between June 2017 and May 2018. The analysis shows that the Czech Republic and Poland have very similar business conditions and almost identical placements in the ranking of surveyed countries. A more detailed assessment of individual sub-areas shows a significant difference in dealing with construction permits for business purposes and in the processes necessary for obtaining a permanent connection to the electricity grid for business purposes and differences in legal enforcement of valid contracts.

**Keywords:** World Bank, Doing Business 2019, Entrepreneurship, Business Environment.

### 1 Introduction

Business environment and the comparison of business conditions is an important parameter of macroeconomic stability and an important determinant of economic growth [4], [7] and [10]. The impact of the macroeconomic business environment on the development of corporate social responsibility has been examined by [5], [8]. These authors have found out that the business environment can affect corporate social responsibility in a variety of ways, and even in unfavourable macroeconomic conditions, companies continue to participate in socially responsible activities due to the fact that they bring them long-term benefits. In order to verify this statement, a quantitative assessment of the quality of institutions is needed. The importance of

business environment has been evaluated in other articles by other authors, for example Carmeli [2], Slavik [12], Petrik [11], Nemec [9], Klapper [6], Chavis [3], and Young [13].

This paper explores World Bank studies, especially the last one from 2018, which focuses on defining individual aspects of the quality of the business environment worldwide. In particular, we will focus on assessing the conditions for doing business in the Czech Republic and Poland.

Business conditions in various countries have been assessed for the last 16 years by World Bank Group and International Bank for Reconstruction. Then, the results are made public in final reports named "Doing Business" [1]. Doing Business 2019 is the 16th in a series of annual reports investigating the regulations that enhance business activity and those that constrain it. The report provides quantitative indicators covering 11 areas of the business environment in 190 economies. The goal of the Doing Business series is to provide objective data for use by governments in designing sound business regulatory policies and to encourage research on the important dimensions of the regulatory environment for firms.

## **2 Methodology and Procedure for Assessing the Quality of Business Environment**

The latest study compares business rules and regulations in 190 countries around the world using 11 key indicators. The overall index is the result of the average value of sub-ratings of only 10 indicators and ranks each compared country in the global ranking, further divided into 7 groups (32 OECD countries, 49 from Sub-Saharan Africa [abb. SSA], 32 from Latin America & Caribbean [abb. LA & C], 25 from Europe & Central Asia [abb. EE & CA], 25 from East Asia & Pacific [abb. EA & P], 19 from Middle East & North Africa [abb. ME & NA], 8 from South Asia [abb. SA]).

In recent years, Doing Business introduced improvements to all of its indicator sets. In Doing Business 2015, Resolving Insolvency introduced new measures of quality, while Getting Credit and Protecting Minority Investors broadened their existing measures. In Doing Business 2016, Dealing with Construction Permits, Getting Electricity, Registering Property and Enforcing Contracts also introduced new measures of quality, and Trading across Borders introduced a new case scenario to increase the economic relevance. In Doing Business 2017, Paying Taxes introduced new measures of postfiling processes and Starting a Business, Registering Property and Enforcing Contracts added gender components.

Each methodology expansion was recalculated for one year to provide comparable indicator values and scores for the previous year. Rankings are calculated for Doing Business 2019 only. Year-to-year changes in the number of economies, number of indicators and methodology affect the comparability of prior years.

Data obtained from the Doing Business 2019 study includes two areas:

- indicators characterizing the strength of legal institutions in the monitored country, namely:

- Getting Credit,
- Protecting Minority Investors,
- Enforcing Contracts and
- Resolving Insolvency
- indicators characterizing the complexity and cost of regulatory processes in the monitored country in the form of an assessment:
  - Starting a Business,
  - Dealing with Construction Permits,
  - Getting Electricity,
  - Registering Property,
  - Paying Taxes and
  - Trading Across Borders.

Within the monitored areas, the indicators are evaluated according to 3-6 additional sub-criteria, which ensure the objectivity of the evaluation and, in particular, the expertise because all individual assessments are done by competent auditing and legal offices in each country. Each of the 10 indicators has the same weight in the overall rating, but it does not mean that the country ranked first in the overall rankings ranks first in sub-ratings. What is important is the average placement of the country according to all individual sub-areas.

### **3 Ease of Doing Business Ranking and Ease of Doing Business Score**

The ease of doing business ranking compares economies with one another; the ease of doing business score (EODB) benchmarks economies with respect to regulatory best practice, showing the absolute distance to the best regulatory performance on each Doing Business indicator. When compared across years, the ease of doing business score shows how much the regulatory environment for local entrepreneurs in an economy has changed over time in absolute terms, while the ease of doing business ranking can show only how much the regulatory environment has changed relative to that in other economies. In this formulation the highest score represents the best regulatory performance on the indicator across all economies since 2005 or the third year in which data for the indicator were collected.

The economies that rank highest in the ease of doing business (see Tab. 1) are those that have consistently well-designed business regulation or whose regulatory environments have thrived thanks to comprehensive reform over the years. The top three economies this year - New Zealand, Singapore and Denmark - exemplify a business-friendly environment. These countries have been at the top of the ranking since 2010. Denmark pushed out of the top three Hong Kong in 2015. New Zealand has led the list since 2016, it came second in 2014-2015, and third between 2010–2013. New Zealand has achieved the overall leadership in the last year thanks to the first position in Starting a Business, Registering Property, Getting Credit that is only three criteria out of 10. On the other hand, it is weak in the Trading Across Borders area,

where it ranks 60<sup>th</sup>, or in Getting Credit, 45<sup>th</sup> place, in Resolving Insolvency, 31<sup>st</sup>, or in Enforcing Contracts, where it is 21<sup>st</sup>. Singapore ranks first only in Enforcing Contracts, whereas its worst ranking is in Trading Across Borders, where it ranked 45<sup>th</sup>. Denmark leads only in Trading Across Borders. In this category, 15 other European Union countries share this placement with Denmark. In Starting a Business, New Zealand comes first, whereas Venezuela is the last. In the Dealing with Construction Permits category, Hong Kong leads the ranking, while Syrian Arab Republic, Libya, Yemen, Eritrea, and Somalia trail far behind. In the Getting Electricity category, the United Arab Emirates is in pole position, with South Sudan, Yemen, Eritrea and Somalia on the other side of the ranking. New Zealand is ranked first in Registering Property, whereas the Marshall Islands, Micronesia, Timor-Leste and Libya ranked the last. In the Getting Credit category, both New Zealand and Brunei Darussalam, an East Asian economy with less than 0.5 million inhabitants, are at the top, while Iraq, Libya, Yemen, Eritrea and Somalia come last.

### 3.1 Global Overview

**Table 1.** Ease of doing business ranking – TOP 10.

Rank	Economy	Region	EODB score (2019)	EODB score change (2019/2018)
1	New Zealand	OECD high income	86.59	0.00
2	Singapore	East Asia & Pacific	85.24	+0.27
3	Denmark	OECD high income	84.64	+0.59
4	Hong Kong SAR China	East Asia & Pacific	84.22	+0.04
5	Korea Rep.	OECD high income	84.14	-0.01
6	Georgia	Europe & Central Asia	83.28	+0.48
7	Norway	OECD high income	82.95	+0.25
8	United States	OECD high income	82.75	-0.01
9	United Kingdom	OECD high income	82.65	+0.33
10	Macedonia FYR	Europe & Central Asia	81.55	+0.32
:	:			
33	Poland	OECD high income	76.95	-0.36
35	Czech Republic	OECD high income	76.10	+0.05
42	Slovak Republic	OECD high income	75.17	+0.29
53	Hungary	OECD high income	72.28	+0.34

Notes to Table 1: The ease of doing business ranking ranges from 1 to 190. The ease of doing business score captures the gap of each economy from the best regulatory performance observed on each of the indicators across all economies in the Doing Business sample since 2005. An economy's ease of doing business score is reflected on a scale from 0 to 100, where 0 represents the lowest and 100 represents the best performance.

In the category of Protecting Minority Investors, Kazakhstan leads and, on the contrary, the absolute loser is Somalia. In the category of Paying Taxes, Hong Kong has won first prize, with the last one being Somalia. In the Trading Across Borders category, 16 European Union countries, including the Czech Republic and Poland, lead the pack, while Yemen and Eritrea close it. In the Enforcing Contracts category, Singapore sits at the top, whereas Timor-Leste is at the bottom. In the Resolving Insolvency category, Japan leads, while 23 non-OECD countries are at the back with the same number of points.

### **3.2 Poland and Czech Republic – Details of Doing Business Conditions**

The assessment of the situation of the monitored countries shows the following results (see Table 2).

From the point of view of the complexity and cost of regulatory processes, 4 of the six indicators are clearly better evaluated in the Czech Republic while the remaining 2 are better evaluated in Poland. The Czech Republic is significantly better evaluated in Getting Electricity. The Czech Republic receives a better score than the OECD average in this rating, especially due to the very low number of days before obtaining a permanent electricity connection. The measure captures the median duration that the electricity utility and experts indicate is necessary in practice, rather than required by law, to complete a procedure. The other sub-indicators do not differ significantly. They involve the number of procedures to obtain a permanent electricity connection. A procedure is defined as any interaction of the company employees or the company's main electrician with external parties. The cost was recorded as a percentage of the economy's income per capita. Costs are recorded exclusive of value added tax. Finally, it is the reliability of supply and transparency of tariffs index calculated on the basis of the following six components: duration and frequency of power outages, tools to monitor power outages, tools to restore power supply, regulatory monitoring of utilities' performance, financial deterrents aimed at limiting outages, and transparency and accessibility of tariffs. The strong point in terms of business conditions assessment in Poland is Dealing with Construction Permit. Poland scores better than the OECD average. It differs from the Czech economy significantly in the sub-index – the total number of procedures required to build a warehouse. A procedure is any interaction of the company's employees or managers with external parties. Another significant difference in the indicator – the total number of days required to build a warehouse. The measure captures the median duration that local experts indicate is necessary to complete a procedure in practice. Finally, it is building quality control index (0-15). The building quality control index is based on six other indices – the quality of building regulations, quality control before construction, quality control during construction, quality control after construction, liability and insurance regimes, and professional certifications indices. Three other sub-indicators are favourable for the Czech Republic – Starting a Business, Registering Property, Paying Taxes. The Paying Taxes category is a weak point in evaluating business conditions in Poland. The total number of taxes and contributions paid, the method of payment, the frequency of payment, the frequency of filing and the number of agencies involved for the standardized case study



company during the second year of operation are all relatively low. It includes taxes withheld by the company, such as sales tax, VAT and employee-borne labour taxes. On the other hand, the time which takes to prepare, file and pay (or withhold) the corporate income tax is relatively long, value added or sales tax, and labour taxes, including payroll taxes and social contributions (in hours per year) are relatively high. Other sub-criteria do not cause deterioration as it comes to Paying Taxes. On the contrary, these sub-criteria are comparable to the OECD average. The mentioned sub-criteria for the category of Paying Taxes are in the form of a total tax and contribution rate (% of profit), where the total tax rate measures the amount of taxes and mandatory contributions payable by the business in the second year of operation, expressed as a share of commercial profits and Postfiling index (0–100), where the postfiling index was based on four components-time to comply with VAT refund, time to obtain VAT refund, time to comply with a corporate income tax correction and time to complete a corporate income tax correction. If both VAT and corporate income tax apply, the postfiling index is the simple average of the scores for each of the four components. If only VAT or corporate income tax applies, the postfiling index is the simple average of the scores for only the two components pertaining to the applicable tax. If neither VAT nor corporate income tax applies, the postfiling index is not included in the ranking of the ease of paying taxes.

**Table 2.** Complexity and cost of regulatory processes (2019).

Topic and indicator	Poland	Czech Republic	OECD high income countries	EODB score	EODB score	EODB score
				Poland	Czech Republic	
<b>Starting a business</b>				<b>91.19</b>	<b>82.85</b>	<b>83.56</b>
Procedures (number)	5	8	4.9		(121)	(115)
Time (days)	37	24.5	9.3			
Cost (% of income per capita)	11.8	1.0	3.1			
Minimum capital (% of income per capita)	10.0	0.0	8.6			
<b>Dealing with construction permits</b>				<b>75.41</b>	<b>75.18</b>	<b>56.20</b>
					(40)	(156)
Procedures (number)	12	21	12.7			
Time (days)	153	246	153.1			
Cost (% of warehouse value)	0.3	0.2	1.5			
Building quality control index (0–15)	10	8.0	11.5			
<b>Getting electricity</b>				<b>85.47</b>	<b>81.35</b>	<b>95.36</b>
Procedures (number)	4	3	4.5		(58)	(10)
Time (days)	122	60	77.2			
Cost (% of income p.c.)	17.3	24.1	64.2			

**Table 2.** Complexity and cost of regulatory processes (continued).

Topic and indicator	Poland	Czech Republic	OECD high income countries	EODB score	EODB score	EODB score
				Poland	Czech Republic	
Reliability of supply and transparency of tariffs index (0–8)	7	8	7.5			
<b>Registering property</b>				<b>77.17</b>	<b>76.09</b>	<b>79.74</b>
Procedures (number)	6	4	4.7		<b>(41)</b>	<b>(33)</b>
Time (days)	33	27.5	20.1			
Cost (% of property value)	0.3	4.0	4.2			
Quality of land administration index (0–30)	19.0	25.0	23.0			
<b>Paying taxes</b>				<b>83.32</b>	<b>76.49</b>	<b>81.42</b>
Payments (number per year)	7	8	11.2		<b>(69)</b>	<b>(45)</b>
Time (hours per year)	334	230	159.4			
Total tax and contribution rate (% of profit)	40.7	46.1	39.8			
Postfiling index (0-100)	77.36	90.75	84.41			
<b>Trading across borders</b>				<b>94.21</b>	<b>100.00</b>	<b>100.00</b>
Time to export/import:	0/0	0/0	12.5/8.5		<b>(1)</b>	<b>(1)</b>
Border compliance (hours)						
Cost to export/import:	0/0	0/0	139.1/100.			
Border compliance (USD)			2			
Time to export/import:	1/1	1/1	2.4/3.4			
Documentary compliance (hours)						
Cost to export/import:	0/0	0/0	35.2/24.9			
Documentary compliance (USD)						

In evaluating the strength of legal institutions, it is clear that 3 of the four indicators are better evaluated in Poland than in the Czech Republic (see Table 3). The terms of business in the area of getting credit are significantly more favourable in both countries than the OECD average. However, thanks to credit registry coverage and credit bureau coverage, Poland has a competitive advantage. The Czech Republic has a major problem with protecting minority investors. Even Poland does not reach the average of the OECD countries, but it is rated significantly better than the Czech Republic, where we can observe the major issue with the extent of disclosure. An even more pronounced problem looms in evaluating the Enforcing Contracts criterion. In this criterion, too, both countries are below the OECD average, and the Czech Republic significantly. It is caused, in particular, by the time and cost needed for resolving a commercial dispute through a local first-instance court and the quality of judicial processes.

The last criterion, Resolving Insolvency, is in both Poland and the Czech Republic above the OECD average. The Czech Republic has a competitive edge in this area compared to Poland. It is, in particular, the advantage of a higher recovery rate which is calculated based on the time, cost and outcome of insolvency proceedings.

**Table 3.** Strength of legal institutions (2019).

Topic and indicator	Poland	Czech Republic	OECD high income countries	EODB score Poland	EODB score Czech Republic
<b>Getting credit</b>				<b>64.12</b>	<b>70.00</b>
Strength of legal rights index (0–12)	7	7	6.1	<b>(32)</b>	<b>(44)</b>
Depth of credit information index (0–8)	8	7	6.7		
Credit registry coverage (% of adults)	0	7.2	21.8		
Credit bureau coverage (% of adults)	98.1	80.5	65.3		
<b>Protecting minority investors</b>				<b>64.21</b>	<b>58.33</b>
Extent of disclosure index (0–10)	7	2	6.5	<b>(57)</b>	<b>(72)</b>
Extent of director liability index (0–10)	2	6	5.3		
Ease of shareholder suits index (0–10)	9	9	7.3		
Extent of shareholder rights index (0–10)	6	6	6.4		
Extent of ownership and control index (0–10)	5	7	5.4		
Extent of corporate transparency index (0–10)	8	5	7.6		
<b>Enforcing contracts</b>				<b>67.65</b>	<b>56.38</b>
Time (days)	685	678	582.4	<b>(53)</b>	<b>(99)</b>
Cost (% of claim)	19.4	33.8	21.2		
Quality of judicial processes index (0–18)	11.0	9.5	11.5		
<b>Resolving insolvency</b>				<b>75.21</b>	<b>80.05</b>
Recovery rate (cents on the dollar)	60.8	67.4	70.5	<b>(25)</b>	<b>(15)</b>
Time (years)	3	2.1	1.7		
Cost (% of estate)	15	17	9.3		

**Table 3.** Strength of legal institutions (continued).

Topic and indicator	Poland	Czech Republic	OECD high income countries	EODB score	EODB score
				Poland	Czech Republic
Outcome (0 as piecemeal sale and 1 as going concern)	1	1	:		
Strength of insolvency framework index (0–16)	14	14	11.9		

## 4 Conclusion

This paper focuses on assessing business conditions as they have been published by the World Bank this year. For 16 years, this institution has evaluated the conditions for doing business according to a very sophisticated methodology assessing 10 various areas. The interest of the authors was to compare the conditions for doing business in the Czech Republic and Poland. Both countries have very similar history and political and cultural present, but the basic parameter of differentiation is the size of the countries and their respective populations. Poland is four times bigger and has almost 4 times more inhabitants. In the worldwide ranking based on the assessment of business conditions in 190 countries, Poland ranked 33<sup>rd</sup> and the Czech Republic 35<sup>th</sup>. It seems that both countries have very similar business conditions, but there are still differences. As part of the overall evaluation, the first analysed criteria are those relating to the complexity and cost of regulatory processes, then the criteria related to the strength of legal institutions. The complexity and cost of regulatory processes are defined by 6 indicators. Both countries have the same conditions for doing business in the trading across borders indicator. Nonetheless, differences are visible in the dealing with construction permits indicator, where it is clear that, thanks to the number of procedures needed and the time of approval of the process itself, Poland gains a very significant advantage over the Czech Republic. In other indicators, the Czech Republic is evaluated by the World Bank better than Poland. The conditions for business start-ups, getting electricity, registering property and paying taxes are assessed as simpler and less costly in the Czech Republic than in Poland. In another important area of assessment - strength of legal institutions - almost all of the criteria are assessed in favour of Poland. Getting credit, protecting minority investors and, in particular, enforcing contracts are areas where Poland, thanks to the strength of its legal institutions, is gaining significant leverage over the Czech Republic. Only one area out of four is evaluated in favour of the Czech Republic, namely resolving insolvency.

## References

1. Doing Business 2019. <http://www.doingbusiness.org/en/reports/global-reports/doing-business-2019>, last accessed 2018/12/01.
2. Carmeli, A.: High- and low-performance firms: do they have different profiles of perceived core intangible resources and business environment? *Technovation*, 21(10), 661-671 (2001). DOI: 10.1016/S0166-4972(01)00050-5.
3. Chavis, L.W., Klapper, L.F., Love, I.: The Impact of the Business Environment on Young Firm Financing. *World Bank Economic Review*, 25(3), 486-507 (2011). DOI: 10.1093/wber/lhr045
4. Commander, S., Svejnar, J.: Business environment, exports, ownership, and firm performance. *Review of economics and statistics*, 93(1), 309-337 (2011). DOI: 10.1162/REST\_a\_00135.
5. Hategan, C.D., Sirghi, N., Curea-Pitorac, R.I., Hategan, V.P.: Doing Well or Doing Good: The Relationship between Corporate Social Responsibility and Profit in Romanian Companies. *Sustainability*, 10(4), Nr. 1041 (2018). DOI: 10.3390/su10041041.
6. Klapper, L. F., Parker, S.C.: Gender and the Business Environment for New Firm Creation. *World bank research observer*, 26 (2), 237-257 (2011). DOI: 10.1093/wbro/lkp032.
7. Korner, P., Kudrna, Z., Vychodil, O.: Measuring business environment quality in Central Europe. *Finance a úvěr*, 52(12), 674-697 (2002).
8. Krajnakova, E., Navickas, V., Kontautiene, R.: Effect of macroeconomic business environment on the development of corporate social responsibility in Baltic Countries and Slovakia. *Oeconomia Copernicana*, 9(3), 477-492 (2018). DOI: 10.24136/oc.2018.024.
9. Nemec, J.: Business environment - The problem of economic conditions or institutional system difficulcy? *Ekonomicky casopis*, 51(2), 137-167 (2003).
10. Odehnal, J., Michalek, J.: An empirical analysis of the business environment of selected european union regions. *Politicka ekonomie*, 59(2), 242-262 (2011). DOI: 10.18267/j.polek.783.
11. Petrik, B.: The formation of the business environment, its problems and outlooks. *Ekonomicky casopis*, 49 (3), 527-538. (2001).
12. Slavik, S., Jurikova, B.: Variability and complexity of Slovak business environment (external conditions for uprise of a competitive advantage). *Ekonomicky casopis*, 50 (2), 217-234 (2002).
13. Young, S.: What do researchers know about the global business environment? *International marketing review*, 18(2), 120-129 (2001). DOI: 10.1108/0265133011038 9963.

## Single Minute Exchange of Die and Innovations are Join Vessels

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**Abstract.** Competitive capability of companies is increased by many methods, companies are still looking for other ways to increase their efficiency. One of these ways is Lean Manufacturing, which includes a very effective method called Single Minute Exchange of Die (SMED), which reduces the time needed for the changeover. The need for this method still grows with bigger and bigger customization of products. As a result of customization, the number of changeovers grows too. The setup activities which do not interfere with the equipment, and which can be carried out without interrupting production, are determined as being external activities. Many internal activities can be transformed to external or make them more efficient by innovations. The article describes not only the benefits of innovation in a selected manufacturing company but also explains the benefits of implementing the Single Minute Exchange of Die method in general. It is mainly the overall increase of the company's efficiency, better use of the workforce and the technological development of the company thanks to the incentives for innovation resulting from the output of the SMED method. The aim of the article is to collect the current knowledge about the method, case studies and a summary of the general benefits of the method application.

**Keywords:** Single Minute Exchange of Die, Lean, Lean Manufacturing. Lean Innovation.

### 1 Introduction

Lean manufacturing is a philosophy based on the resource-efficient economy. It shows how important it is to eliminate wasting which arises during the production process. The most significant resource of wasting is overproduction, retooling, failures, scrap, inventory, movement, or transport. It is possible to reduce these kinds of wasting by 5S, Total Production Maintenance, Value Stream Mapping, Just in Time and many others [8]. It also helps to meet the client's requirements in required quality and desired delivery time [5].

Many companies designate, as the best possible choice, the small-scale production where many types of customized products are required. The most significant difference and also the problem between small and large-scale production is the high increase in the number of changeovers [7]. Production efficiency depends on many different

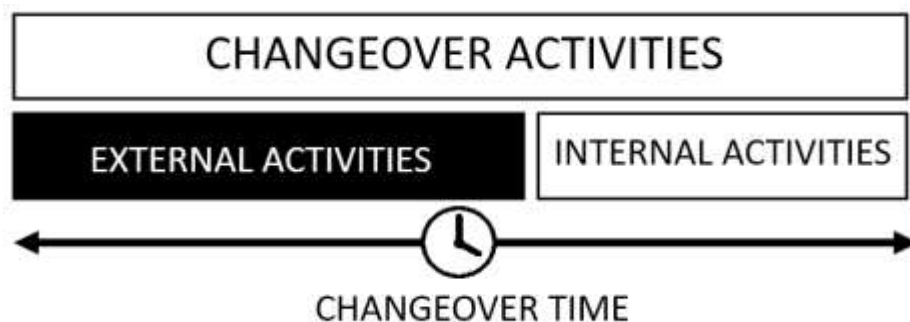
factors, changeover is one of the most time-consuming, non-value-added activity in many industries. Particularly in the case of frequent changeover in small-scale production, this type of wasting has a considerable impact on the overall efficiency of the company. Some reduction is necessary in this case [2].

Single Minute Exchange of Die (SMED) was developed in the middle of the 20th century by Shigeo Shingo, the Toyota employee. With this method he has achieved excellent results on car body molding procedure thanks to the organization of processes and simple innovations[4].

## 2 Theoretical Background

Setting up, changing tools, rebuilding machines, etc. are often the last areas to look for wasting and inefficiency. Each rebuilding is a waste because it is not the added value of the final product and the time consumed for the changeover could be used for production [8]. These activities are often wasting time especially during the time that production workers are waiting for finishing of the changeover. Production is not possible during this time. The SMED system also improves safety and improves workplace ergonomics [4], its main essence is the division of adjustment operations into two basic categories:

- Internal activities (tool adjustment, exchange of rotate parts, etc.) that can only be performed when the machine is stopped.
- External activities (transport from the warehouse, preparation of all necessary parts and tools, presetting of various parts), which can be performed even when the machine is running [6].



**Fig. 1.** - Internal and external operations – SMED.

The key aspect of SMED methodology is the distinction between changeover activities when the machine is not running (internal activities) and activities where the machine can be started (external activities). The SMED reduces the time when the machine is stopped. The SMED method consists of one preparatory [2] and three main steps [3]:

- Step 0 provides a complete overview of the changeover process, such as a checklist, observation, or changeover manual [2].
- Step 1 focuses on dividing activities into two of the above groups by asking: "Do I have to stop the machine to do this?"
- Step 2 transforms an internal activity into external. It can drastically reduce the non-productive time. These savings can be achieved by adjusting the device, removing long settings when the machine is stopped or standardizing the size of tools.
- Step 3 increases and simplifies all aspects of the internal and external operations undergoing during changeover by using the specific principles and innovations [3].

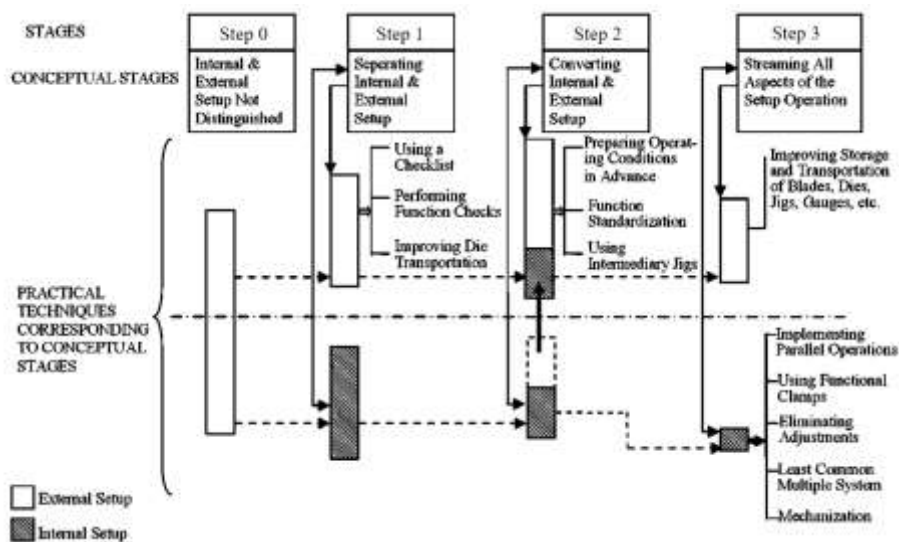


Fig. 2. SMED – Steps [3].

SMED focuses exclusively on machine changeover operations, but in many cases changeovers are affected by the previous type of production. This justifies the development of new methods that help professionals to detect inadequate optimization in other business processes which can reveal the underlying causes of problems for example with previous operations or with the previous product type [2].

Changeover time is the time elapsed between making the last good piece of the first dose and the first good piece of the second dose. SMED method is often compared with pit stops in Formula 1 racing, where tank filling, tire replacement, repairs, and other activities have to take place in the shortest possible time [1]. Activities should be analyzed from a different point of view in order to objectively describe all steps and activities, including at first sight obvious shortcomings [7].



### 3 Case Study

This method has been applied in a medical company which manufactures plasters, tampons, instruments, and Medisets. Paret's diagram found that the most downtime in the Medisets workplace was due to the changeovers of machines to various types of products, which are around 1500. When the machine is in the changeover, the machine is stopped, and the workers are waiting for the adjustment to be done by the adjuster. Due to the significant number of product types, it is not possible to analyze and create a proposal for improvement for all types of products, so the changeovers are divided into several types, and the SMED method is used to optimize them.

All lines work on a similar principle, their basis of which are forms of different dimensions, including several types of forms, through which the foil is formed. The foil is used in several thicknesses, like paper that is welded together with the foil after filling of the components.

One shift has up to fifty changeovers. For this reason, it is highly desirable to shorten the changeovers to the shortest possible time, because the time is profitable only when the line can run.

#### 3.1 Step 0

The first phase of SMED is to find available information about the changeover, for example, checklist or standards. In some cases, it is possible to analyze and optimize the standards. Employees do not have to work according to the standards, but they can often do it at their own discretion. The best option is therefore direct observation or video recording of the process. The record can be later conveniently analyzed into detail or used for educational purposes. Another advantage is to save time by creating a Spaghetti diagram directly from the record. Selected types of rebuilds were filmed and processed. As an illustration of this article, a Tiromat changeover was selected to replace paper, print and shaping vats. The following table shows setter's activities. The diagram on the right of the table shows the sequence of activities and their time requirements. The dark grey color depicts the waste, the light grey activities that should be external, black are internal activities, and the white color indicates innovations. The column labeled Time represents the duration of each activity, the sub-column then shows the cumulative activity time. The total length of this changeover is greatly prolonged by many trays between the molding of the tub and the final cut. The total time from the line stop to the first correct piece of the product is 10 minutes and 21 seconds.

Table 1. SMED – Step 0.

Working step	Time	Time cumulatively	Timetable: 0 - 11 Minutes										
			1	2	3	4	5	6	7	8	9	10	11
Last good piece	0:00:00	0:00:00											
Walking to the forms	0:00:08	0:00:08											
Access to the form	0:00:12	0:00:20											
Walking for forms	0:01:13	0:01:33											
Replacement of the form	0:00:25	0:01:58											
Covering the forms	0:00:07	0:02:05											
Walking	0:00:07	0:02:12											
Paper change	0:00:40	0:02:52											
Preparation of the label	0:00:41	0:03:33											
Label printing	0:00:20	0:03:53											
Preparation of paper print	0:00:45	0:04:38											
Printing of paper	0:00:12	0:04:50											
Starting the machine	0:00:21	0:05:11											
Waiting for new paper to be loaded	0:01:31	0:06:42											
Inserting the material to the forms	0:00:42	0:07:24											
First good piece	0:02:57	0:10:21											

### 3.2 Step 1

The activities that can be performed while the line is running, before the changeover is started, are often performed as internal operations, and the time needed to carry out the changeover is disproportionately increasing. In the first step of the SMED, these activities will be sorted out without the line stops. During analyzing it is critical to talk with all of the setters. Some of them can improve the changeover process themselves. As mentioned in the null phase, the preparation of label and paper printing is an activity that can be done without the machine stopping and even walking is a waste of time that needs to be eliminated. That is why bringing forms is allocated as an external operation. The setter must prepare the necessary forms directly on the line before the start of the changeover. Another item among the external list activities is the transition forms from the line's output to the opposite side.

**Table 2.** SMED – Step 1.

Working step	Time	Time cumulatively	Timetable: -3 - 8 Minutes										
			-3	-2	-1	1	2	3	4	5	6	7	8
			External activities			Internal activities							
Walking to the forms	-0:00:08	-0:02:47											
Walking for forms	-0:01:13	-0:02:39											
Preparation of the label	-0:00:41	-0:01:26											
Preparation of paper print	-0:00:45	-0:00:45											
Last good piece	0:00:00	0:00:00											
Access to the form	0:00:12	0:00:12											
Replacement of the form	0:00:25	0:00:37											
Covering the forms	0:00:07	0:00:44											
Walking	0:00:07	0:00:51											
Paper change	0:00:40	0:01:31											
Label printing	0:00:20	0:01:51											
Printing of paper	0:00:12	0:02:03											
Starting the machine	0:00:21	0:02:24											
Waiting for new paper to be loaded	0:01:31	0:03:55											
Inserting the material to the forms	0:00:42	0:04:37											
First good piece	0:02:57	0:07:34											

If the operator stops the product line at the output with the last correct piece, the setter can immediately begin replacing the forms. Getting ready to print labels and paper is another significant time-saving. The setter should take a laptop with him for the changeover, where he can prepare labels with the necessary information before he starts. According to the information obtained from the setters, it is possible to send the necessary data to the printer directly even if it is running, then just confirm the new printing. On the other hand, in the case of a label printer, it is not possible to send data while the printer is running. So it is necessary to prepare the data so that it can be printed simply by using the keyboard shortcut Ctrl + P. Delegating these activities will take 2 minutes and 47 seconds to save, and the total time is reduced to 7 minutes and 34 seconds. The value in the first row of the table, in the cumulative sum column, shows the time needed to prepare before the changeover. This time could be displayed on the monitor above the appropriate line. The setter would have more time to organize his work.

### 3.3 Step 2

In the second step, internal operations are converted to external. There is space for software and hardware innovations because small innovations can change the process. It is possible here to make software innovation with the printer. Now it is not possible to send new print data to the printer without stopping printing. This line has many choices to increase efficiency by innovations — for example, the innovative way how to change forms, new way how to guide cover paper into the line or change foil guidance. These innovations have a lot of potentials.

### 3.4 Step 3

The third step of the SMED method reduces and speeds up changeovers and concerns both internal and external activities. The most significant change is to eliminate the waiting time for the scrolling of new paper. The paper is rolled out from the roller through the roller system in which two meters of paper are stretched. When starting up, the machine must form several drums corresponding to two meters of foil. By innovation during stretching and attaching old and new paper to the last accessible drum before the printer is fed by paper the waiting time is shortened for more than 1 and a half minutes. This work step was set aside among external operations, resulting in the ten-second paper change needed to stretch the paper through the guide roller system. The total changeover time is reduced by more than 41% from 10 minutes and 21 seconds to almost 6 minutes.

**Table 3.** SMED – Step 3.

Working step	Time	Time cumulatively	Timeline: -5 - 6 Minutes											
			-5	-4	-3	-2	-1	1	2	3	4	5	6	
			External activities						Internal activities					
Waiting for new paper to be loaded	-0:01:31	0:00:00												
Walking to the forms	-0:00:08	-0:02:47												
Walking for forms	-0:01:13	-0:02:39												
Preparation of the label	-0:00:41	-0:01:26												
Preparation of paper print	-0:00:45	-0:00:45												
Last good piece	0:00:00	0:00:00												
Access to the form	0:00:04	0:00:04												
Replacement of the form	0:00:25	0:00:29												
Covering the forms	0:00:03	0:00:32												
Walking	0:00:07	0:00:39												
Paper change	0:00:50	0:01:29												
Label printing	0:00:20	0:01:49												
Printing of paper	0:00:12	0:02:01												
Starting the machine	0:00:21	0:02:22												
Inserting the material to the forms	0:00:42	0:03:04												
First good piece	0:02:57	0:06:01												

## 4 Results and Discussion

This article was developed with the aim of reducing changeover by application of the SMED methodology and description of innovations resulting from the method. Pareto's analysis revealed the greatest downtime in the workplace called Mediset's. The largest of these is the changeover of machines to another type of production. For this type of downtime, the SMED method was applied, which aims to set aside the external actions performed during the changeover without stopping the line which increases the productivity. SMED method saved on the analyzed working environment more than 40 % of the time required for the changeover. Optimization has been done by innovation of paper guidance. Optimization of all types of rebuilding will result in very

significant savings as up to 50 changeovers are made per day which takes up to several hours a day at this workplace. The output of this method is incentives for improvement and innovation. Further optimization can be done through more complex or simpler innovations in the production line which can achieve greater efficiency.

## References

1. Ahmad, R., Soberi, M.S.F.: Changeover process improvement based on modified SMED method and other process improvement tools application: an improvement project of 5-axis CNC machine operation in advanced composite manufacturing industry. *The International Journal of Advanced Manufacturing Technology*. 94, 1–4, 433–450 (2018), DOI:10.1007/s00170-017-0827-7.
2. Braglia, M. et al.: SMED enhanced with 5-Whys Analysis to improve set-up reduction programs: the SWAN approach. *The International Journal of Advanced Manufacturing Technology*. 90, 5–8, 1845–1855 (2017), DOI: 10.1007/s00170-016-9477-4.
3. Cakmakci, M.: Process improvement: performance analysis of the setup time reduction-SMED in the automobile industry. *The International Journal of Advanced Manufacturing Technology*. 41, 1–2, 168–179 (2009), DOI: 10.1007/s00170-008-1434-4.
4. Chiarini, A.: *Lean Organization: from the Tools of the Toyota Production System to Lean Office*. Springer Milan, Milano (2013), DOI: 10.1007/978-88-470-2510-3.
5. Martins, M. et al.: A Practical Study of the Application of SMED to Electron-beam Machining in Automotive Industry. *Procedia Manufacturing*. 17, 647–654 (2018), DOI: 10.1016/j.promfg.2018.10.113.
6. Mašín, I., Vytlačil, M.: *Nové cesty k vyšší produktivitě: metody průmyslového inženýrství*. Institut průmyslového inženýrství, Liberec (2000), ISBN: 978-80-902235-6-1.
7. Shingō, S.: *A revolution in manufacturing: the SMED system*. Productivity Press, Stamford, Conn (1985) ISBN: 978-0-915299-03-4.
8. Comparative Analysis of the Implementation of the SMED Method on Selected Production Stands. *Tehnicki vjesnik - Technical Gazette*. 25, Supplement 2, (2018) DOI: 10.17559/TV-20160411095705.

## Financial Management in Czech Enterprises Depending on their Size

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**Abstract.** This text aims to present the latest knowledge of enterprise practice within the financial management sphere. This text contains following information: who in the company serves as the financial manager, what is the most common way of financing, what is the most frequent method of investment evaluation, what financial plans the enterprises prepare and what information is used by enterprises in accounting statements. The research has shown that there are two different groups. The first group includes micro and small companies that are financially managed by their owner, or their executive manager. The second group includes middle and large companies having their own financial manager. In addition it was found that the foreign capital belongs to the most frequently used form of financing only for small companies. The research has also found that a great portion of companies does not use any method of investment evaluation. The payback period and net current value belong among the most frequently used methods. It was also found that short-term financial plan is the most often used one. As for the balance informational function, all companies, regardless their size, use this statement for their assets management, on the contrary the profit and loss statement is used as the most often information for operational costs management across companies of all sizes. The presented research has confirmed several statements that could be expected nevertheless it also found new information or detailed the current one.

**Keywords:** Financial Management, Financial Planning, Methods of Investment Evaluation.

### 1 Introduction

This text aims to present the latest knowledge of enterprise practice within the financial management sphere. This text contains following information: who in the company serves as the financial manager, what is the most common way of financing, what is the most frequent method of investment evaluation, what financial plans the enterprises prepare and what information is used by enterprises in accounting statements.

This paper based on an own questionnaire survey and so it can describe actual situation in financial management in the Czech Republic. All type of businesses across the country were addressed.

## **2 Statement of a Problem**

The first problem was to determine what a business is. An enterprise may be associated with a legal person, but it may also be tied to an entrepreneur – an individual. [18]. During the questionnaire survey, a problem arises that many respondents do not compile a balance sheet, a profit and loss statement, and cash flow. Some people set up a balance sheet and a profit and loss statement, but not a cash flow statement. As a result of the statistical calculations, these respondents had to be taken into account while not excluding them from the research, as this would affect the results. The author has assigned the task of mapping all businesses, so called micro enterprises as well.

### **2.1 Financial Management Tasks**

The company financial management (financial management) has four main tasks [17, 2, 5, 14]:

- To provide the capital for common as well as extraordinary needs of the company and to decide on its structure and structure changes, i.e. on activities related to liabilities shown in the balance,
- To decide on capital allocation, i.e. activities related namely to assets in the balance, based on methods for investment decision-making,
- To decide on the profit distribution,
- To predict, plan, note, analyse, check and manage the economic part of the company so that its financial stability is assured, which in fact means the capability of the company to pay its liabilities.

### **2.2 Ownership Separated from the Financial Management**

The author of this article does not primarily rank the profit distribution among financial management competencies. In the same way, some principal decisions within the scope of financing or capital allocations can belong to the competency of a higher body. Thus it is important to state that the financial manager tasks depend on the competency of that persons who performs such position.

In the vast majority of companies, the ownership and the company management are separated. Only in case of smaller companies the owner or some of owners also manages the company [1]. The separation of ownership and company management is namely noticeable in joint stock companies where the shareholders, being the owners, assign some managing authorities to managers, through the Board of directors of the joint stock company [7].

Then the ownership separated from the company management can logically initiate issues due to different interests of owners and managers. The different interests among owners (shareholder) and managers are for example seen in the sphere of long-term and short-term goals conflict, revenue maximizing strategy, over-estimated acquisitions, and risks in relations with suppliers, employees and customer and in the different approach of managers and owners to risks [2].

Marek [13] defines the situation in which the owners engage the so-called agents as the so-called costs of representation.

### **2.3 Procuring of Capital**

As for the financial manager task to provide the capital, the authors Hrdý & Krechovská [6] state a list of financing kinds based on various points of view. The author believes that own external capital, undistributed profit, supplier credit, financial leasing and bank loans are the form of financing used mostly by every company.

### **2.4 Investment Evaluation**

As for the financial manager task that consists in the evaluation of potential investment and within the competency scope to decide on its performance the method defined for it should be followed. Besides the simple statistic methods (for example the payback period) there are also advanced methods of investment decision-making that include the factor of time. They include the internal rate of return, rentability index and the net current value [4, 8, 9, 11,16].

### **2.5 Financial Planning**

The financial management is performed through a financial plan.

The financing planning differs based on the size of company. While in large companies the financial planning has its strong position among particular company processes, linked to strategic concepts and with defined organisational as well as time course, it is scheduled rather at its operative level in smaller companies [6].

## **3 Methods**

### **3.1 Respondents Selection**

During the first half of 2018 660 questionnaires concerning the financial management were received. The questionnaire asked about the size of company (based on the company classification in the Directive for entrepreneurs [19, 21]), financial manager person, most often way of financing, investment evaluation methods, financial plans and use of information based on accounting statements. 202 questionnaires were erroneous and thus they had to be eliminated. Thus 458 questionnaires were processed of which 182 were from micro companies, 144 are small companies, 84 middle companies and 48 large companies.



### 3.2 Data selection

202 questionnaires were erroneous and thus they had to be eliminated. Thus 458 questionnaires were processed of which 182 were from micro companies, 144 are small companies, 84 middle companies and 48 large companies.

### 3.3 Hypothesis

Based on the chapter 2 following hypothesis were defined:

- H1: in small companies the financial manager person is also the company owner, whereas in larger companies such person is separated from the owner,
- H2: way of company financing independent of the company size,
- H3: the use of investment decision-making methods is independent of the fact whether the company prepares their long-term financial plan,
- H4: companies that prepare their long-term financial plan also prepare their short-term financial plan,
- H5: the use of information from the balance does not depend on the company size,
- H6: the use of information from the profit and loss statement does not depend on the company size.

### 3.4 Research Methods

The questionnaires were processed with the program Excel, using the contingency table function [10, 12] and frequency function [12] and the independency test was also performed [12] because of non-compliance with the assumption of normal distribution.

The independency test belongs among non-parametric tests unless the division normality presumption is fulfilled [20]. But it has its limits and thus could not be used in all intended examples.

The independency test is based on real received data from which the expected values are calculated. These two matrices are subsequently compared, and the sum of their variations means the value for statistic testing.

The independency test limits are based on the presumption that the expected joint frequencies shall be higher than 5 (some texts present the requirement for joint frequencies above 1 and minimally 80 % of all joint frequencies higher than 5) [12].

The further limit consists in the fact that no zero can be in any place of numbers of really received frequencies because, when comparing the real and expected values, the frequency of real values frequency is in the denominator and thus it would not be possible to perform the calculation.

As for the results of performed research the questionnaire structures are divided in following five groups: financial manager person, the most often way of financing, methods of investment evaluation, financial plans and use of information contained in accounting statements. Following sub-chapters statistically analyse individual groups and, in some case, the possible dependency among them is searched.

## 4 Research Results

As for the results of performed research they are divided, based on the above stated hypothesis, in following five groups: financial manager person, the most often way of financing, methods of investment evaluation, financial plans and use of information contained in accounting statements. Following sub-chapters statistically analyse individual groups and, in some case, the possible dependency among them is searched.

### 4.1 Financial Manager Person

The respondents were asked to state what person in their company is most devoted to the financial management. They had following options to choose: external company (consultant), external accountant, financial director (economist), general director, internal accountant, executive manager and owner. The Table 1 show the frequency of particular responses based on the company size.

**Table 1.** Contingency table Financial manager person based on the company size.

Person	Micro company	Small company	Middle company	Large company
External company (consultant)	2	0	0	1
External accountant	4	0	0	0
Financial director (economist)	8	13	42	35
General director	0	4	6	3
Internal accountant	4	15	8	3
Executive manager	45	47	14	1
Owner	134	55	12	2

It results from the table above that in larger companies there are financial economists whereas in micro and small companies the owner, or the executive manager performs the function of financial manager.

### 4.2 Most often Way of Financing

The respondents were asked to choose the most often way of financing from following: bank loan, supplier credit, financial leasing, undistributed profit, own external. The frequency of answers is shown in the Table 2. The bank loan and own external capital belong among the most often used way of financing.

**Table 2.** Contingency table The most often way of financing based on the company size.

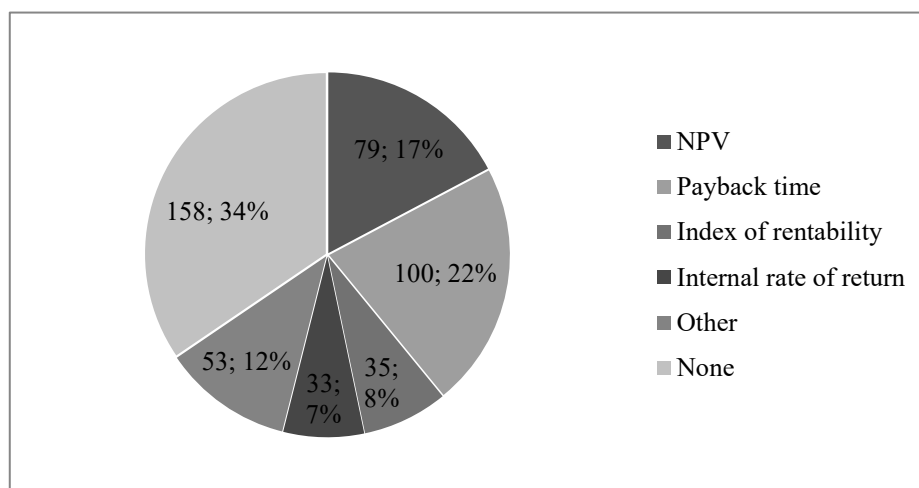
The most often way of financing	Micro company	Small company	Middle company	Large company	Total
Bank loan	42	52	35	13	142
Supplier credit	4	5	2	1	12
Financial leasing	13	26	18	5	62
Undistributed profit	28	28	32	15	103
Own external	86	23	15	15	139

In addition, the dependency of company size on the preferred way of financing was investigated using the independency test. At the importance level 95 % (note: this level was defined for all test hypothesis) it was calculated that the value of test criterion belongs into the critical zone. Thus, the hypothesis of independency was refused and it was proven that the company size influences the way of financing.

#### 4.3 Methods of Investment Evaluation

The Figure 1 shows the apportionment of investment evaluation methods. The respondents were asked to choose the most often used method for investment effectiveness evaluation from the following: net current value (ČSH), payback period (DN), rentability index (IR), internal rate of return (VVP) or other. They also could choose that no method is used.

The performed research showed that 34 % of companies do not use any method for evaluation of their investments. The most often used method consists in the statistic method of investment payback used by 22 % of respondents. 17 % use the net current value.



**Fig. 1.** The most often used methods of investment evaluation.

With regard to the fact that the investment decision-making belongs among the long-term financial plans it was tested using the independency test in order to check whether the chosen methods relate to the fact that the company prepares its long-term plan. It was statistically found that the use of investment evaluation method really relates (in positive way) to the preparation of long-term financial plan. On the contrary companies that do not prepare any long-term plan usually do not use any methods of investment evaluation.

#### 4.4 Financial Plans

Another task for the respondents was to answer whether they prepared any operative plan, any short-term or long-term plan. For the purpose of clear understanding it was explained that the operative plan is for 1-3 months, the short-term plan is for 3-12 months and the long-term plan is for the period longer than 1 year. The number of positive answers, based on the company size, is shown in the Table 3.

**Table 3.** Companies preparing their financial plans- absolute frequency.

Companies	Operative plan	Short-term plan	Long-term plan
Micro	98	94	54
Small	90	106	72
Middle	61	77	62
Large	39	44	41
Total	288	321	229

The Table 4 shows the relative frequency with regard to the total number of respondents in particular sizes of companies. The micro and small companies rather compile their operative and short-term plans whereas the middle and large companies often also prepare their long-term financial plans.

**Table 4.** Companies preparing their financial plans – relative frequency.

Companies	Operative plan	Short-term plan	Long-term plan
Micro	68%	65%	38%
Small	49%	58%	40%
Middle	73%	92%	74%
Large	81%	92%	85%

The independency test also has shown that the companies that prepare their long-term plans also formulate their operative plan as well as that the short-term plan creation is related to the preparation of operative plan.

#### 4.5 Use of Data from Accounting Statements

The last part of the questionnaire was aimed to find out whether the data from accounting statements are used by companies for the purpose of financial management. The following tables 5, 6, 7 show the summary of research results within these statements: balance, profit and loss statement, cash flow statement.

**Table 5.** Use of data from the balance – based on the company size.

Kind of information	Micro company	Small company	Middle company	Large company	Total
Management of time assets and liabilities structure	61	62	54	44	221
Capital structure management	16	17	8	1	42
Assets management	105	65	22	3	195

It results from the Table 5 that the companies most often use the data from the balance to manage the time assets and liabilities structure whereas the micro companies emphasize the assets management. It results from the statistic independency test that the informational balance character depends on how big the company is.

**Table 6.** Use of profit and loss statement data – based on the company size.

Kind of information	Micro company	Small company	Middle company	Large company	Total
Margin optimizing	11	7	10	8	36
Depreciation processing	8	2	0	0	10
Revenues predictions	37	26	15	15	93
Wage costs management	10	15	13	2	40
Operational costs management	113	94	46	19	272
Interest expenditures management	3	0	0	4	7

It results from the Table 6 that all companies, regardless their size, unambiguously prefer the operational costs management.

#### **4.6 Hypothesis Testing**

The performed independency tests confirmed or disproved the defined hypothesis as this summary shows:

Hypothesis H1: the financial manager person is the owner in small companies, whereas in larger companies the separation of the owner was confirmed.

Hypothesis H2: that the way of company financing is independent of the company size was disproved.

Hypothesis H3: that the use of investment decision-making methods is independent of the fact whether the company prepares its long-term financial plan was refused.

H4: that the companies prepare their long-term financial plan, they create also their short-term financial plan, was confirmed.

H5: that the use of the balance data is independent on the company size was confirmed.

H6: that the use of the profit and loss statement data is independent on the company size was confirmed.

### **5 Conclusion**

This text aimed to present the latest knowledge of enterprise practice within the financial management sphere. This text contains following information: who in the company serves as the financial manager, what is the most common way of financing, what is the most frequent method of investment evaluation, what financial plans the enterprises prepare and what information is used by enterprises in accounting statements. In relation to it the hypothesis H1 to H6 were formulated.

In respect of the person who performs the financial management in the company it was confirmed that the owners take over this function in micro and small companies and that the separate function of financial manager exists in middle and large companies. The research thus has revealed that there are two different groups. The first group includes micro and small companies, financially managed by their owners, or executive manager. The second group covers middle and large companies that have their own financial managers.

As for the most often way of financing it was found that the micro companies most often choose own external capital whereas the small companies do not hesitate to have the majority of foreign capital. Middle companies are equally interested in own as well as foreign capital. And large companies prefer rather their own capital. It results from the research that the foreign capital belongs among the most often ways of financing only for small companies.

As for the investment evaluation it was confirmed that the fact that the company prepares its long-term plan positively influences the fact that it also systematically evaluates its investments. The research has found that 34 % of companies in total do not use any method of investment evaluation. On the contrary, the most often used methods include the payback period (22 %) and the net current value (17 %).

Another point of the research covered the financial plans prepared by companies. It was found that the most often financial plan is the short-term financial plan for 3-12

months. It was confirmed that the larger the companies are, the most they pay attention to their financial planning, for example only 38 % of micro companies prepare their long-term plan.

The last part of the research was aimed to find out what information from financial statements are the most often used one by companies. As for the balance, all companies, regardless their size, use this statement for their assets management which is right as Brealey and Myers [4] state that the money are generated on the assets' side. As for the profit and loss statement all companies across all their sizes indicated one item of this statement as the most often used information. It means the item of operational costs management. On the contrary, the depreciations as the source of self-financing were the least often used information from the profit and loss statement.

The presented research has confirmed several statements that could be expected nevertheless it also found new information or detailed the current one.

During the research a limiting factor for investment evaluation methods was found. The respondents could also mark in their answers that they use another method. Due to the technical form of the questionnaire it was not possible to detail what method is concerned. With regard to the fact that 12 % of responded marked the answer of another investment evaluation method, it would be surely interesting to find out what other methods are used by companies.

A limitation on the research results could be taken as the fact that no research related to the business field was mentioned in the research. Although the primary intention was to compare the size of the enterprise (in connection with the above) it would be interesting to consider the business aspect for further research as well.

## References

1. Accenture, Chartered Institute of Managements Accountants (CIMA): Sustainability performance management: How CFOs can unlock value. 1st edn. CIMA, London (2011).
2. Block, S., Hirt, G.: Foundations of Financial Management. 1st edn. Irwin Burr Ridge, Illinois (1994).
3. BPP Learning Media: Advanced Financial Management. 3rd edn. BPP Learning Media, London (2009).
4. Brealey, M., Myers, S.: Principles of Corporate Finance. 1st edn. McGraw-Hill, New York (2003).
5. Dluhošová, D.: Finanční řízení a rozhodování podniku. 3rd. edn. Ekopress, Praha (2010).
6. Hrdý, M., Krechovská, M.: Podnikové finance v teorii a praxi. 1st ed. Wolters Kluwer ČR, Praha (2013).
7. Hrdý, M., Strouhal, J.: Finanční řízení. 1st edn. Wolters Kluwer ČR, Praha (2010).
8. Jindřichovská, I.: Finanční management. 1st edn. C.H. Beck, Praha (2013).
9. Kanrath, R.: Long-term Financing Decision: Views and Practices of Financial Management of NYSE Firms. The Financial Review, 32(2), 331-356 (1997). DOI: 10.1111/j.1540-6288.1997.tb00428.x.
10. Kozel, R., Mynářová, L., Svobodová, H.: Moderní metody a techniky marketingového výzkumu. 1st edn. Grada Publishing, a. s., Praha (2011).
11. Levy, H., Sarnat, M.: Capital Investment and Financial Decisions. 5th edn. Prentice Hall, New Jersey (1994).

12. Marek, L. et al.: Statistika pro ekonomy. 2nd edn. Professional Publishing, Praha (2007).
13. Marek, P. et al.: Studijní průvodce financemi podniku. 1st edn. Ekopress, Praha (2009).
14. Ross, S. A., Westerfield, R. W., Jaffe, J.: Fundamentals of Corporate Finance. 7th edn. McGraw-Hill, New York (2006).
15. Saniuk, S.: Production orders planning in a network of small and medium-sized enterprises. Contemporary problems in managing production and services supporting manufacturing process. 1st edn. Wydawnictwo Politechniki Lodzkiej, Lodz (2009).
16. Švecová, L., Scholleová, H., Fotr, J.: Vybrané aspekty investičního rozhodování (poznatky z empirických výzkumů). E+M. Ekonomie a management, 15(3), 125-141 (2012).
17. Synek, M. et al.: Podniková ekonomika. 3rd edn. C.H. Beck, Praha (2002).
18. Vomáčková, H.: Podnik nebo závod obecně a v účetní praxi. Český finanční a účetní časopis. 9(1), 125-131 (2014).
19. Vyhláška č. 500/2002 Sb. pro podnikatele ve znění pozdějších předpisů.
20. Walker, I.: Výzkumné metody a statistika. 1st edn. Grada Publishing, a. s., Praha (2013).
21. Zákon č. 563/1991 Sb. o účetnictví ve znění pozdějších předpisů.



## Interest Expenses as a Technique of Profit Shifting Used by Slovak Companies

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**Abstract.** The use of tax havens is both controversial and attractive for the academic community. Most research and output is associated with providing empirical evidence of shifting taxable profits from jurisdictions with higher tax to lower or zero tax jurisdictions. Various methods and techniques are used to shift profits, and we intend to analyze in greater detail one of the often-used profit shifting techniques. This paper aims to analyze the impact of the transfer of registered offices of Slovak companies to tax havens on the level of the reported ratio of interest expenses per assets before and after the transfer of the registered office to selected jurisdictions. In addition to statistical testing of the selected indicator before and after seat migration, we also provide a comparison of a selected indicator between Slovak companies' ownership links with tax havens and Slovak companies with no ownership links with tax havens. We divide tax havens into three categories, onshore, midshore and offshore jurisdictions. In our analysis, we use two databases. The first is the Bisnode database, which lists the Slovak companies with the owner in selected jurisdictions between 2005-2015. The second database is the datasets of the financial statements of Slovak companies for individual years prepared and provided by Finstat.

**Keywords:** Interest Expenses, International Holdings, Tax Havens, Profit-Shifting, Tax Planning.

### 1 Introduction

The use of interest expenses in the area of international tax planning and tax optimization belongs to frequently used methods and techniques of shifting taxable profits to low or zero tax jurisdictions. In addition to tax optimization itself, when mentioning internal debt financing within equity-linked companies (holding companies), we also mention the benefits of control by debt, so the majority creditor can take legal action to control the company. With tax optimization, it is essential to recognize interest as a tax expense under conditions that consider the so-called thin-capitalization rules and the EU Directive on interest and royalty payments (the EU Interest and Royalties Directive). While the European Directive can be used between associated companies of different EU Member States, thin-capitalization rules are unilateral measures at the national level. Thin-capitalization rules are included within

the Slovak Income Tax Act 2015 (§ 21a on Income Tax Act) and allow for the possibility of including interest and associated costs for loans and borrowing up to a maximum of 25% of EBITDA into tax expenses. The theoretical economic literature on profit shifting suggests that a foreign subsidiary will use more internal debt if the multinational holds another subsidiary in a low-tax jurisdiction and if the spread between the host-jurisdiction tax rate and the lowest tax rate within the multinational group is large.

This paper focuses on analyzing the use of the selected channel of profit shifting from the Slovak Republic into selected jurisdictions and the proposal of methodology in this particular field, which is also applicable in the field of research in other countries.

## **2 Literature Overview**

Thin-capitalization rules are part of the BEPS project (Basic Erosion and Profit Shifting), and in October 2015 the OECD made a best practice recommendation in Article 4 suggesting a Fixed Ratio Rule to replace thin-capitalization rules. Low-capitalization rules have been taken into account since the 1960's, and the OECD report on thin-capitalization rules was published in 1986. The new Fixed Ratio Rule solution can be considered more effective than the current low-capitalization regime [14]. Guenther first analyzed the dependence between the level of interest expenses and foreign tax rates and levels of long-term debt for U.S. multinational firms [9]. Results from his model demonstrate that the effect of interest expense deductions on U.S. tax liability depends on the ratio of foreign tax rate to the U.S. rate. Firms with low relative foreign rates receive a tax benefit for interest expenses equal to their U.S. tax rate, while firms with high relative foreign tax rates receive a tax benefit for interest expenses that is less than their U.S. tax rate. Richardson and Davos consider the deductibility of interest expenses as one of the most controversial issues in taxation law, which raises the issue of modification on a regular basis [21]. According to these authors, the existing and potential approaches to the deductibility of interest expenses have their inherent problems and weaknesses (mainly approaches to either limit or restrict the deduction for interest, e.g., economic equivalence, a pro rata allocation of interest or matching interest payments to interest receipts).

The results of Hong and Smart suggest that while income shifting to tax havens may reduce the revenues of high-tax jurisdictions and increase tax base elasticities, it tends to make the location of real investment less responsive to tax rate differentials [10]. Auerbach, Devereux, Keen and Vella describe the technique of profit shifting through the use of debt [2]. This planning technique relies on the deductibility of interest payments under most existing corporate tax systems.

A multinational company is supposed to have two affiliates, one in a high tax country and one in a low tax country. The affiliate in a low tax country requires financing for its business, but instead of using the funds directly from the third-party bank, it is equity funded by the affiliate in the high tax country using funds borrowed from a bank in the high tax country. The interest paid to the bank is deducted from the profit in the high tax country. Vallaste describes the use of internal debt (loan) through international

holding [24]. The financing structure is supposed to have two companies again. The first one (parent company) in the onshore or midshore jurisdiction (e.g., the Netherlands, Cyprus, Malta) and the second in the selected offshore jurisdiction (e.g. Belize) – (grandmother company). The financing structure is appropriately set up after the provision of loans with different interest rates (e.g. loan at 12% interest rate to the subsidiary/borrower in one direction and loan at 10% interest rate from the offshore company to onshore or midshore company).

Buettner, Overesch, and Wamser analyzed the data on German multinational firms, and their findings indicate that introducing thin-capitalization rules or making it tighter exerts significant adverse effects on FDI (Foreign Direct Investment) in high-tax jurisdictions [5]. A multinational firm operating an internal capital market can minimize its overall tax payments by lending from the affiliate facing the lowest tax within the firm to all other subsidiaries [19]. Buettner, Overesch, Schreiber and Wamser state that their findings indicate that thin-capitalization rules effectively reduce the incentive to use internal loans for tax planning but result in higher external debt [4]. Johannesen stresses that unilateral tax provision may not be sufficient as the profit shifting is structured in the international environment and the multinational firms finance foreign investment with a hybrid instrument treated as debt in the host country and equity in the home country [13]. Cross-border hybrid instruments help with generating significant tax savings relative to financing and with standard debt and equity instruments. Maßbaum and Sureth-Sloane in a general capital structure model analyzed if thin capitalization rules affect dividend and financing decisions and whether they can partially explain why corporations receive both debt and equity capital (Belgian, German and Italian rules as examples) [18]. They find that the so-called Miller equilibrium and definite financing effects depend significantly on the underlying tax system and its tax parameters.

Mardan shows that the optimal level of internal interest deductions decreases with the financial development of the host country [17]. Kollruss states that the introduction of a new thin-capitalization-rule under the German Tax Reform Act in 2008 marked one of the deepest cuts in modern German tax history [15]. As a consequence of the new act, tax planning opportunities for German Corporations reducing their high tax burden by using cross-border intragroup debt financing structures have been limited massively. Under the new German Corporate Income Tax Act, net interest expenses of a German corporation are tax deductible only up to 30% of the taxable profit (EBITDA) per current fiscal year. Buettner and Wamser, based on their analysis of German firms, consider the empirical magnitude of interest deductions as overestimated as a technique of profit shifting [6]. According to their results, the upper limit for the implied tax-elasticity of reported profits due to profit shifting is around 0.11%. However, the existing literature estimates point at figures of 1.3% or 2%. They further argue that the low tax sensitivity of internal debt can be explained by indirect effects related to the taxation of the parent company. They consider the Controlled Foreign Corporation (CFC) rules to be an effective tool against profit shifting to low tax jurisdictions. When they took into consideration the German CFC rules when measuring the profit shifting tax incentives, the predictive power of the tax incentive and its effects on an internal debt increase. This finding has interesting implication for the U.S. case, where

according to Altshuler and Grubert, the so-called "check-the-box" rule allows U.S. multinationals' tax haven subsidiaries to circumvent the CFC rule [1]. This suggests that the U.S. multinationals engage more in profit shifting using internal debt than their German counterparts, and also that the empirical tax sensitivity of internal debt should be higher in the U.S. case. Grubert finds that the most critical channel for profit shifting within multinational firms is associated with the allocation of research and development (R&D) expenditures [8].

### 3 Methods, Objective and Data

This article aims to assess the use of interest deductible expenses (loans) by Slovak companies as the channel for profit shifting to low tax jurisdictions. The use of interest expenses belongs among the techniques of profit shifting and it is the subset of using debt channel (debt financing). The indicator of interest expenses per assets will be analyzed as a critical lever. The examined indicator was selected, respectively derived based on Reuter, who appoints the using of debt among the several other variables that capture profit shifting behavior [20]. We have been monitoring the change of this indicator within Slovak companies before and after relocating the official seat to selected jurisdictions. At the same time, we compared the indicator (and its differences) between Slovak companies with and with no ownership links to tax havens (parent company as the owner come from the preferential tax jurisdictions).

The list of Slovak companies that have moved to tax havens (2005-2015) was obtained from the Bisnode database. The financial statements of all Slovak companies were drawn from the financial statements of the dataset provided by Finstat.

We have divided into three categories, jurisdictions marked by Bisnode as tax havens:

- OFFSHORE JURISDICTIONS (OFF): Bahamas, Belize, Bermuda, British Virgin Islands, Gibraltar, Guernsey (United Kingdom), Jersey (United Kingdom), Cayman Islands, Marshall Islands, the Netherlands Antilles, Panama, Man Island, and Seychelles;
- MIDSHORE JURISDICTIONS (MID): Hong Kong, Cyprus, Malta, United Arab Emirates, United States of America;
- ONSHORE JURISDICTIONS (ON): Liechtenstein, Latvia, Luxembourg, Monaco and the Netherlands.

From the nature of the business conditions, taxation and disclosure of information on ultimate beneficial owners (UBO), tax havens are most commonly divided into onshore and offshore categories. Offshore financial centers (pure tax havens) are generally defined as jurisdictions in which the financial sector is disproportionately more significant than the domestic economy. In the onshore category we can find mainly jurisdictions with a diversified economy and a classic tax system but often designed to provide opportunities for substantial tax cuts for companies [7, 25]. Some sources still use the so-called midshore category, most frequently as Cyprus, Malta or Hong Kong [23]. While the division of the individual jurisdictions to the offshore category is almost

automatic, as the other jurisdictions, we have decided on the division between onshore and midshore categories mainly because of their use and the costs needed to set up and manage companies. This categorization will help us to better interpret the trends in behavior in the field of use of the investigated technique of profit shifting. Some authors analyse profit shifting by testing multinational companies' ownership links to individual tax havens rather than to groups of them [e.g. 12].

We have researched the Slovak companies whose owners come from the preferential tax jurisdictions (direct capital connection - the owner registered in the Slovak Business Register). This has led to the creation of an international holding structure. According to Liška and Sabolová, holding structures are indispensable, particularly in the field of investment protection under international treaties, in the case of requirements to maintain a high degree of anonymity of the ultimate beneficial owner, in the use of special preferential tax regimes and some servicing activities (such as marketing, financing and purchasing) [16].

## 4 Results

In the first part of the analysis, we monitored the change of the indicator of interest expenses per assets before and after the transfer of the registered office to selected jurisdictions (tax havens). For this analysis, data was available for a total of 669 Slovak companies. The relatively low number of available companies' financial statements (both before and after the transfer to tax haven) was caused for example by the fact, that almost 60% of Slovak companies moved their registered office to tax havens within three years of being established. We used a non-parametric Wilcoxon test (before the statistical analysis we identified 2% of the outliers that we excluded from the analysis) (Table 1).

**Table 1.** Descriptive characteristics of interest expenses per assets.

		BEFORE	AFTER
N	Valid	655	655
	Missing	0	0
Mean		.0326	.1085
Median		.0059	.0103
Std. Deviation		.10600	.91033

In the analyzed sample of enterprises, the median value of the indicator of interest expenses per assets before the transfer of the registered office was 0.0059 (interest expenses constituted 0.59% of the assets), while after the change of the registered office, the median value of this indicator increased to 0.0103, that creates an increase of 75%. This difference was shown to be statistically significant (p-value 0.007) at a significance level of 0.01.

The drop in the indicator was recorded in 295 Slovak companies, and the increase was recorded for the remaining 360 companies. Although based on the Wilcoxon test results, we reject the hypothesis of a statistically insignificant difference before and

after the change of residence. The indicator dropped in 45% cases (remaining 55% increase), which can be considered as insufficient evidence to claim that after the change of the place of residence, the indicator of interest expenses per assets increases. In the analyzed sample of enterprises, 39% of the companies showed the current increase in assets as well as an increase in interest expenses, of which 5.6% of the companies had a percentage increase in the assets higher as a percentage increase in the interest expenses, which led to a decrease in the indicator. Also, interesting is the fact that 27% of the companies showed zero interest expenses before the transfer of the headquarters and were non-zero after the transfer (it can be assumed that the investigated profit shifting technique was automatically used after formation of ownership link with tax haven).

We also analyzed whether the change of indicator after the relocation of the ownership is statistically significant from the view of jurisdiction category (Table 2a and 2b).

**Table 2a.** Wilcoxon Signed Ranks Test – individual categories.

Jurisdiction			N	Mean Rank	Sum of Ranks
MID	After-before	Negative ranks	110 <sup>a</sup>	128.28	14111.00
		Positive ranks	163 <sup>b</sup>	142.88	23290.00
		Ties	0 <sup>c</sup>		
		Total	273		
OFF	After-before	Negative ranks	18 <sup>a</sup>	23.00	414.00
		Positive ranks	23 <sup>b</sup>	19.43	447.00
		Ties	0 <sup>c</sup>		
		Total	41		
ON	After-before	Negative ranks	167 <sup>a</sup>	169.10	28240.00
		Positive ranks	174 <sup>b</sup>	172.82	30071.00
		Ties	0 <sup>c</sup>		
		Total	341		

Note: a. AFTER < BEFORE

b. AFTER > BEFORE

c. AFTER = BEFORE

**Table 2b.** Wilcoxon Signed Ranks Test – individual categories.

Jurisdiction		After-before
MID	Z	-3.515 <sup>a</sup>
	Asymp. Syg. (2-tailed)	.000
OFF	Z	-.214 <sup>a</sup>
	Asymp. Syg. (2-tailed)	.831
ON	Z	-.503 <sup>a</sup>
	Asymp. Syg. (2-tailed)	.615

Note: a. Based on negative ranks.

b. Wilcoxon Signed Ranks Test.

The nonparametric Wilcoxon test showed a statistically significant difference in the value of the observed indicator only for companies in the midshore jurisdictions. The increase in the indicator was reported by 60% of Slovak companies, which moved to jurisdiction in the midshore category. In the case of the offshore category, 56% of the companies reported an increase, and in the case of the onshore category, it was only 51% of the companies. What is interesting, however, is the view of the median values of the surveyed indicator. The highest median value of the pointer is in onshore jurisdictions, and its value is almost the same before and after the change of residence (before 0.0123, after 0.0121). The highest difference in median value after the change of residence is in midshore jurisdictions, where the indicator rises from 0.0028 to 0.0088, which represents a threefold increase.

In offshore jurisdictions, the median value rose almost 15-times from 0.0003 to 0.0045. Offshore companies are primarily used on the first level of ownership to achieve a higher degree of anonymity of the ultimate beneficial owner. The profit shifting from the Slovak company directly through the offshore company is inefficient due to the 35% withholding tax (the Slovak Republic does not have double taxation treaties with the offshore jurisdictions). However, other channels of tax base minimization can be used through debt, and the offshore company can only be a means to cover the owner. The expectation that the highest median value after relocation will be mainly for the midshore category has been confirmed, mainly due to the popularity of Cyprus and Malta with Slovak companies.

In particular, Cyprus is being used because of the wide possibilities of using tax and accounting laws in the field of tax optimization. The founding and management of companies in Cyprus is also significantly lower compared to the Netherlands and Luxembourg of the onshore category, although at a result of a worsening company image (Dutch companies are also the most commonly used as the seat of Slovak companies - 27%, from the perspective of invested share capital up to 52 %). In the Netherlands, the standard corporate income tax rate is 20%, resp. 25% and cannot be further optimized (often further owned by the offshore company on the second level). Companies that have moved to the Netherlands or Luxembourg have high values of the indicator before the transfer. Most often moves of headquarters to the Netherlands were with companies operating within the NACE sector of wholesale and retail; professional, scientific and technical activities and real estate activities.

Specifically, we tested the change in the investigated indicator for the Netherlands and Luxembourg (A), where there was no statistically significant difference (p-value 0.881). For Cyprus and Malta (B), a statistically significant difference (p-value of 0.000) was already recorded (Table 3 and 4).

**Table 3.** Descriptive characteristics (A).

		BEFORE	AFTER
N	Valid	333	333
	Missing	0	0
Mean		.0531	.0583
Median		.0129	.0127
Std. Deviation		.21893	.27795

**Table 4.** Descriptive characteristics (B).

		BEFORE	AFTER
N	Valid	183	183
	Missing	0	0
Mean		.0256	.1626
Median		.0033	.0141
Std. Deviation		.07212	1.04778

If we compare only the selected jurisdictions of the Netherlands and Luxembourg vs. Cyprus and Malta, the median value of the indicator before the change of residence is higher in the Netherlands and Luxembourg. However, after the change of residence, the median value is higher in the Cyprus and Malta group. The assumption is that Cypriot and Maltese companies are most often used in aggressive tax planning (cost of corporate structure vs. potential range of tax savings). The Netherlands and Luxembourg are used more frequently by large and profitable (richer) companies. It is also expected that large and richer companies could invest more in tax optimization channels respecting the local tax settings. We also analyzed the change of indicator in the NACE sector. We only focused on selected NACE sectors where the total number of companies on the total amount was more than 10%. The highest median value is shown by NACE sector *real estate activities* - an increase of 18%. The most significant percentage change in the median value of the indicator was reported by companies in the *wholesale, retail and repair of motor vehicles sector* - a 6.3-times increase. Companies in the NACE sector of *professional, scientific and technical activities* showed a 10% decrease in the median value of the indicator and the *manufacturing industry* decreased by 8% (Table 5).



**Table 5.** Median value changes by NACE sectors.

SK NACE sector	BEFORE	AFTER	Change	P-value
Real estate activities	0.0234	0.0277	18% increase	0.09
Professional, scientific and technical activities	0.0107	0.0096	10% decrease	0.954
Wholesale, retail trade and repair of motor vehicles	0.0010	0.0063	530% increase	0.001
Manufacturing industry	0.0062	0.0057	8% decrease	0.058

Before the analysis, we assumed that the highest median values would be for the sectors *real estate activities* and *wholesale, retail and repair of motor vehicles*. The assumption in the median values was reached in the *real estate activities* sector, on the other hand, the increase in the indicator after the transfer of the seat to the tax haven occurred in only 54% of cases. Similarly, 54% of companies showed an increase in the observed indicator in the *professional, scientific and technical activities* sector. For the *wholesale, retail and repairs of motor vehicles* sector, the most significant increase in the median value of the indicator was observed, with an increase of up to 65%. In the *manufacturing industry*, only 39% of companies reported an increase in median value.

Statistical significance at the significance level of 0.01 was recorded only for the *wholesale, retail and repair of motor vehicles*. There was no significant statistical difference in the observed indicator due to the transfer of ownership to the tax haven of other sectors.

In the sphere of monitoring trends of behavior of Slovak companies, the use of the technique of deductible expenses for the purpose of profit shifting is important in addition to monitoring changes following the transfer of a tax domicile to a comparison of median values between Slovak companies located in the tax haven with those Slovak companies that do not have their registered office in the tax haven. Therefore, we have chosen a different view of the investigated indicator, which would be more logical to prove whether the Slovak companies use the investigated technique of profit-shifting.

Again, we used the same data sources as in the previous analysis, working with the company database as of 2015. We had 56,407 companies based in the Slovak Republic and 1,227 Slovak companies based in the tax havens - ownership link to tax havens. In the analysis, we did not work with the entire dataset of companies without linking to the tax havens, but we randomly generated about 10% of the companies and compared the value of the indicator of these two groups of companies. Due to the high variability of data in both groups of companies, we compared the median values of the monitored indicator (Table 6).

**Table 6.** Descriptive characteristics – with and with no links to tax havens

With no links	N	Valid	5649
		Missing	0
	Mean		0.214
	Median		0.0083
	St. Deviation		.12862
With links	N	Valid	1227
		Missing	0
	Mean		0.539
	Median		0.0117
	Std. Deviation		.34419

The median value of the indicator of interest expenses per assets is 41% higher in companies with ownership link to tax haven than Slovak companies with no links to tax havens. The Mann-Whitney nonparametric test showed a statistically significant difference in the indicator on a significance level of 0.01 (p-value 0.000).

## 5 Discussion

The thin-capitalization rules were introduced in the Slovak Republic only with effect from 2015. Our analysis, therefore, examined data, trends in the behavior and the use of the technique of profit shifting under conditions without thin-capitalization rules. The impact of the introduction of the thin-capitalization rules on the use of debt channel as technique of profit shifting should be investigated in Slovakia in the near future. Research methodology in this area could be similar to that proposed by, for example, Maßbaum and Sureth-Sloane or Buettner, Overesch and Wamser, that the effect of the thin-capitalization rules on the use of interest expenses as profit shifting technique depends on the underlying tax system and its tax parameters [4, 18]. The analysis in the broader context of setting up the Slovak tax system will also allow looking at other channels of tax optimization as for example dividends or R&D. Our empirical results suggest that the Slovak companies use the method of interest deductible expenses in a way as described by more authors [e.g. 2, 19, 24]. The basic prerequisite for the implementation of the investigated technique is ownership link on tax havens. The list of tax havens should, in our opinion, be longer than that produced by Bisnode. There is a lack of onshore jurisdictions there, for example, Great Britain with which ownership links were up to 1,303 Slovak companies as of 2nd quarter of 2018 [3]. If we look specifically at the Netherlands and Luxembourg in the analysis, it turned out that the companies that moved their headquarters into these jurisdictions had a median of 0.0129 to 0.0127. Our results are comparable with Mardan, who shows that the optimal level of internal interest deductions decreases with the financial development of the host country [17]. The Netherlands and Luxembourg are considered one of the most developed jurisdictions in the area of tax planning, property protection, and investment. Regarding the type of jurisdictions, it would be interesting in the future to focus on what types of profit shifting channels are used in individual home countries regarding

their NACE business sectors. Our empirical results show that the NACE sector also influences the use of individual profit shifting techniques and methods in addition to the choice of the parent company (e.g., the use of interest expenses as debt channel in the NACE sector of real estate activities is more used than in the manufacturing industry).

## 6 Conclusion

Our analysis of the indicator of interest expenses per assets showed that Slovak companies with ownership links to tax havens demonstrated an increased value of this indicator compared to other Slovak companies with no ownership links to tax havens by 41%. A statistically significant difference was also demonstrated in the median values of the indicator followed after the transfer of the seat of the Slovak companies to the tax haven (75% increase). So, it is visible, based on our empirical results (based on the analysis of data between 2005 and 2015) that Slovak companies use the debt financing technique, respective of interest deductible expenses for profit shifting to low tax jurisdictions. When testing a statistically significant difference in the value of the indicator before and after the change of residence by jurisdiction category and by NACE sector, we have achieved different results. The statistically significant difference in indicator of interest expenses per assets from the type of jurisdiction was reflected in ownership links to midshore jurisdictions. Up to 61% of Slovak companies that moved their seat to the midshore jurisdiction showed an increased median value of the indicator after the relocation. We believe that the main reason for using these jurisdictions is their preferential tax regimes and accounting system and the relatively low costs of setting up and managing companies in those jurisdictions versus the potential range of tax savings. A statistically significant difference was not demonstrated in onshore jurisdictions (51% increase in the indicator). The median values in this category before and after the transfer of tax residence remained almost the same, but these values are the highest or at the level of the midshore category after relocation. Regarding NACE sector, the highest median values are recorded in the real estate business sector and the highest increases in the NACE sector is with wholesale, retail, and repair of motor vehicles (up to 530%). Although, given the above-mentioned limitations (incomplete list of tax havens and low number of companies tested), our analysis does not have to provide sufficient evidence to claim that after the transfer of residence there is an increase in the indicator of interest expenses per assets. Our results create minimally the base to deduce the tendency in the behavior of selected Slovak companies with regard to the use of the investigated technique of profit shifting out of the Slovak Republic.

**Acknowledgements.** This contribution was supported by grant scheme VEGA 1/0767/18 “SMART model - a decision support tool in the management of enterprises.”

## References

1. Altshuler, R., Grubert, H.: Governments and Multinational Corporations in the Race to the Bottom. *Tax Notes International*. 41(5). 459-474 (2016).
2. Auerbach, A., J., Devereux, M., P., Keen, M., Vella, J.: International Tax Planning under the Destination-Based Cash Flow Tax. *National Tax Journal*. 70(4). 783-802 (2017). DOI: 10.17310/ntj/.2017.4.04.
3. Bisnode: Počet slovenských firiem s britským vlastníkom v prvom polroku klesol. Základný kapitál naopak narástol. <https://www.bisnode.sk/o-bisnode/o-nas/novinky/pocet-slovenskych-firiem-s-britskym-vlastnikom-klesol/>. last accessed 2018/08/17.
4. Buettner, T., Overesch, M., Schreiber, U., Wamser, U.: The impact of thin-capitalization rules on the capital structure of multinational firms. *Journal of Public Economics*. 96(11-12). 930-938 (2012). DOI: 10.1016/j.jpubeco.2012.06.008.
5. Buettner, T., Overesch, M., Wamser, G.: Anti-profit shifting rules and foreign direct investments. *International Tax and Public Finance*. 25(3). 553-580 (2018). DOI: 10.1007/s10797-017-9457-0.
6. Buettner, T., Wamser, G.: Internal debt and multinational profit-shifting: Empirical evidence from firm-level data. *National Tax Journal*. 66 (1). 63-96 (2013).
7. Foad, H., Lundberg, C.: The determinants of portfolio investment in offshore financial centers. *International Review of Financial Analysis*. 54(November 2017). 76-86 (2017). DOI: 10.1016/j.irfa.2017.08.003.
8. Grubert, H.: Intangible Income, Intercompany Transactions, Income Shifting, and the Choice of Location. *National Tax Journal*. 56 (1). 221-242 (2003).
9. Guenther, D., A.: Foreign Tax Rates and the Marginal Benefit of Interest Expense for U.S. Multinationals. *Journal of International Accounting, Auditing and Taxation*. 5(2). 147-160 (1996).
10. Hong, Q., Smart, M.: In praise of tax havens: International tax planning and foreign direct investment. *European Economic Review*. 54(1). 82-95 (2009). DOI: 10.1016/j.eurocorev.2009.06.006.
11. Income Tax Act No. 595/2003 Coll. As later amended. the Slovak Republic.
12. Jánský, P., Kokeš, O.: Profit-shifting from Czech multinational companies to European tax havens. *Applied Economics Letters*. 23(16). 1130-1133 (2016). DOI: 10.1080/13504851.2015.1137543.
13. Johannesen, N.: Tax avoidance with cross-border hybrid instruments. *Journal of Public Economics*. 112(April 2014). 40-52 (2014). DOI: 10.1016/j.jpubeco.2014.01.011.
14. Kayis-Kumar, A.: What's BEPS got to do with it? Exploring the effectiveness of thin capitalization rules. *eJournal of Tax Research*. 2 (14). 359-386 (2016).
15. Kollruss, T.: Tax optimal cross-border debt financing under the new German Thin-capitalization-Rule (German interest Barrier) Intra fiscal group cross-border financing via a foreign fiscal group finance branch. *Investment Management and Financial Innovations*. 7(2). 87-99 (2010).
16. Líška, L., Sabolová, L.: Holdingové struktúry. Odborná konferencia Mezinárodné plánování a správa majetku v digitálním světě. 1st edn. Akont. Praha (2017).
17. Mardan, M.: Why countries differ in thin capitalization rules: The role of financial development. *European Economic Review*. 91(January 2017). 1-14 (2017). DOI: 10.1016/j.eurocorev.2016.09.003.
18. Maßbaum, A., Sureth-Sloane, C.: Thin Capitalization Rules and Entrepreneurial Capital Structure Decisions. *BuR Business Research Journal*. 2(2). 147-169 (2010).

19. Mintz. J., Smart. M.: Income shifting, investment, and tax competition: Theory and evidence from provincial taxation in Canada. *Journal of Public Economics*. 88(6). 1149-1168 (2004). DOI: 10.1016/S0047-2727(03)00060-4.
20. Reuter. P.: *Draining Development? Controlling Flows of Illicit Funds from Developing Countries*. 1 st edn. World Bank License. Washington DC (2012).
21. Richardson. G., Devos. K.: The deductibility of Interest Expense in Anglo-American Countries: A Comparison and Review of Policy. *Revenue Law Journal*. 9(1). 33-57 (1999).
22. The Council of the European Union: Council Directive 2003/49/EC of 3 June 2003 on a common system of taxation applicable to interest and royalty payments made between associated companies of different Member States.
23. The Economist: Storm survivors. <https://www.economist.com/special-report/2013/02/16/storm-survivors>. last accessed 2018/07/11.
24. Vallaste. R.: *Advantages of Estonian Corporate Tax System*. 1st edn. Wolters Kluwer. Praha (2017).
25. Weizig. F., Van Dijk. M.: The global problem of tax havens: the case of the Netherlands. SOMO – Centre for Research of Multinational Corporation. [https://www.somo.nl/the-global-problem-of-tax-havens-the-case-of-the-netherlands/publication\\_3464/?searchterm=tax](https://www.somo.nl/the-global-problem-of-tax-havens-the-case-of-the-netherlands/publication_3464/?searchterm=tax). last accessed 2018/08/15.

## Cluster Policy Based on Key National Clusters – a Case of Poland

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**Abstract.** The paper discusses cluster policy or cluster-based policy as a widely used phenomenon in many countries of the world, and as an element of innovation, industrial policy or broadly understood development policy. It can be noticed by observations of advanced cluster policies existing in highly developed countries that in the early phase of existence of such programs, all clusters and cluster initiatives receive support. At a later stage, however, key clusters are selected, which receive significant financial, training, and infrastructural support, and which are selected in national competitions. The paper aims to present a cluster policy based on the functioning of key clusters on the example of Poland. The article will review the latest literature on cluster policy, tools relevant in various countries will be presented, and then the selection and support for key clusters will be presented on the example of Poland. In the last part, an attempt will be made to assess the effectiveness and validity of the presented model of cluster policy which is based on key clusters in Poland.

**Keywords:** Cluster Policy, Key National Clusters, Poland.

### 1 Introduction

Cluster policy or cluster-based policy is widely used in many countries of the world as an element of innovation, industrial policy or broadly understood development policy. Cluster policy is a collection of various tools used to support cluster activities in individual national economies. It can be noticed by observations of advanced cluster policies existing in highly developed countries that in the early phase of existence of such programs, all clusters and cluster initiatives receive support. At a later stage, however, key clusters are selected, which receive significant financial, training, and infrastructural support, and which are selected in national competitions. The paper aims to present a cluster policy based on the functioning of key clusters on the example of Poland. Currently, cluster policy analyses focus on the policy as a whole of activities, without specifying the functioning of key clusters constituting at the same time a specific tool and the target group of beneficiaries of this policy. The article aims to fill this gap, because, according to the author's opinion, the creation and existence of key clusters is a factor shaping the cluster policy and its effectiveness and efficiency in the redistribution of resources including financial resources. The article will review the

latest literature on cluster policy, tools relevant in various countries will be presented, and then the selection and support for key clusters will be presented on the example of Poland. In the last part, an attempt will be made to assess the effectiveness and validity of the presented model of cluster policy which is based on key clusters in Poland.

## 2 Cluster Policy – Theoretical Approach

It can encounter definition problems of cluster policy identical with the difficulty in clearly defining the concept of the cluster. Just as two identical clusters in different locations cannot be created, which results from the diverse external environment of the cluster, a universal set of cluster policy tools cannot be created as well. This is mainly due to the fact that national economies differ widely and there are different goals and assumptions of this policy. Individual national or regional governments have a different level of, for example, financial outlays, which can be an element of support for national clusters. The existence of many different models is also related to the different affiliation of cluster policy to innovation, development, industrial policy, etc. For this reason, it can be assumed that “cluster policy is multi-dimensional, multi-instrument policy, informed by a mix of rationales. The development of clusters, therefore, means different things in different places” [12].

An important element in defining a cluster policy is identifying the level that this policy applies to. According to Lehmann and Menter, “Public cluster-based policy and cluster development could be defined as the policy-making use of the regional or local level in order to pursue regional or national goals” [9]. According to the European Union definition “modern cluster policies aim to put in place a favourable business ecosystem for innovation and entrepreneurship in which new winners can emerge and thus support the development of new industrial value chains and ‘emerging industries’” [15].

By many different definitions of cluster policy, one can assume a certain generalisation that links cluster policy with stimulating broadly understood competitiveness of cluster entities and regions in which clusters operate. It is also connected with deepening the specialisation of regions (smart specialisation), with innovation and regional development. „Cluster policy can be placed somewhere between a nationally oriented industry policy that promotes a narrowly defined set of industries, or “national champions”, and a broad regional innovation policy prioritising the development of regional capabilities and regional institutional thickness “ [12].

According to Borrás there are following cluster policy categories, but it can be concluded that the differences are sometimes hard to identified [1]:

- creationist – in this approach cluster policy can be understood as a set of tools for the creation of new clusters. the policy aims to address the problems connected with the specific dynamics of the clusters and the policy embedded in the wider state – society – economy interactions,
- narrow – this approach is based on the more practical way of thinking about cluster policy, where all the instruments are connected with the public support actions,

- top – down – the cluster policy should be focused on formal programs and designed public actions created on national – regional level,
- evolutionary – the task for cluster policy is to upgrade the knowledge base, the competences, and the learning abilities of the territory to improve the level of competitiveness of a cluster,
- network – in this approach the links between public and private activities are needed and essential to the development of clusters.

Cluster policy, regardless of its category, has been widely used for many years, and now one can notice its dynamic development and its more and more conscious application. Cluster policies, started to be implemented in the early 1990s, there are three main stages in their development that can be observed:

- The early 1990s: pioneer countries and regions attentively studied the cluster approach and took risks to develop competitiveness or innovation orientated policies based on it.
- The mid-1990s to mid-2000s: this period of ‘cluster policy entrepreneurs’ was characterised by first results from pioneer countries and a general broadening of knowledge on the possibilities for developing a successful regional policy through clusters.
- The mid-2000s till around 2010: cluster policy is increasingly mainstream as more and more regions, and countries introduce the policy due to successful results of previous implementations. The question changes from whether or not to implement, towards how to implement to achieve the most effective results [8].
- Around 2010 onward: the integration of cluster efforts into regional policies. The smart specialisation approach outlines the need to foster structural change alongside a focus on regions’ existing strength [10]. The cluster policy is strongly connected with innovation policy and is carried out more consciously.

Just as the definition of cluster policy is varied, so also does not exist one defined set of tools for this policy. This is due to the specificity of each country, the level at which the cluster policy is implemented, the financial resources available for clusters, and even the understanding of the concept of the cluster in individual countries. However, the following tools that are successfully used in well-developed cluster policies can be indicated [13]:

- providing incentives for exports,
- attracting investment resources,
- regulation of the labour market, encouraging the growth of human capacity,
- targeted regulation of innovation activity,
- stimulation of research activities to the needs of industry,
- budget allocations knowledge-intensive businesses,
- tax reduction on investments in innovation,
- development of the scientific and technological partnership,
- providing tax credits and preferential taxation of companies carrying out a program of innovation,



- involvement of the initial capital,
- encourage the development of highly specialised regions,
- the attraction of foreign advanced technologies,
- investing in human development,
- formation of the level of development of interaction between scientific institutions and industries.

According to Nishimura and Okamuro cluster policy tools can be divided into six groups, and those are as follow: network formation, R&D support, incubation function, marketing support, financial support, fostering human resources [11].

### **3 Cluster Policy in Poland**

Cluster-based efforts or cluster policy, in general, have already become a natural part of economic policies. This policy is visible not only at the regional level but nowadays also at the national level as a component of innovation and SME support policies in the EU countries [13]. Support for the development of clusters in the European Union has been included in the Europe 2020 Strategy, which assists member states in strengthening smart specialisation and cluster initiatives for the rejuvenation of Europe's industry. In the Europe 2020 Strategy, under the flagship initiative: „An industrial policy for the globalisation era”, The Commission undertook „to improve the business environment, especially for SMEs, including through reducing the transaction costs of doing business in Europe, the promotion of clusters and improving affordable access to finance” [11]. Whereas under the flagship initiative: „Innovation Union” the task of strengthening cooperation between universities, the research community and business has been put forward in the Member States, which is a practical fulfilment of the conditions for the definition of clusters' activities.

Cluster policy in Poland results in a way from European policy and is carried out in similar time horizons, which is most often the result of the functioning of EU budgets. Assumptions for current activities have been included in such documents as National Development Strategy until 2020, Enterprise Development Program for 2020 and Directions and assumptions of cluster policy in Poland by 2020. In the National Development Strategy until 2020, clusters are perceived as a factor improving the country's competitiveness and deepening regional specialisation. In this document and many others, clusters are to constitute an important lever for the development of Polish exports, both in traditional and modern industries, such as ICT or automotive. The task of active cluster policy will be, inter alia, to support the most innovative and showing the highest potential for development of Polish clusters that are able to create highly-competitive products and services constituting Polish and European export specialities [16].

Principal aim of the Polish cluster policy is to strengthen the innovativeness and competitiveness of Polish economy through intensified cooperation, interactions and knowledge transfer (that is through providing support for existing and newly created clusters) as well as through supporting the development of key

economic specializations (that means selecting key national and regional clusters and focusing part of public support on them).

The achievement of the principal aim involves the fulfilment of the following specific aims [2]:

- stimulation of internal interactions, knowledge transfer and cooperation as well as the creation of necessary social capital;
- expansion of the external networking of clusters and entities operating within them, especially in cross-sector and international dimension,
- strengthening of joint and integrated strategic planning processes within clusters,
- the increase of the number of innovative goods and services offered on domestic and international markets by companies and entities operating within clusters, which should lead, among other things, to the growth of export,
- the mobilisation of private investment in clusters, including the creation of new companies and inflow of foreign investment as well as increasing private spending on R&D and innovation-oriented activities,
- the development of the ecosystem of supporting institutions (e.g. education and research institutes, technological parks and technology transfer centers, etc.) and better customisation of their offer and activities to the needs of companies operating within the clusters,
- boosted the effectiveness of using public funds by their concentration and obtaining synergy between different policies and support instruments (e.g. concerning infrastructure development, human capital, R&D, promotion, internationalisation, etc.).

The functioning of clusters will be based on a market and participatory model, meaning the leading role of the private sector in their initiation, financing and management. It is assumed that there are three types of clusters: local clusters (shaping the local economic ecosystem), key regional clusters (of significant importance for the economy of the regions) and key national clusters (recognisable and competitive on a global scale). Depending on the scale of operation, cluster policy will offer diverse support (see figure 1). Currently, a significant part of cluster support as part of cluster policy is addressed to key clusters, which will be discussed in the next section of the article.

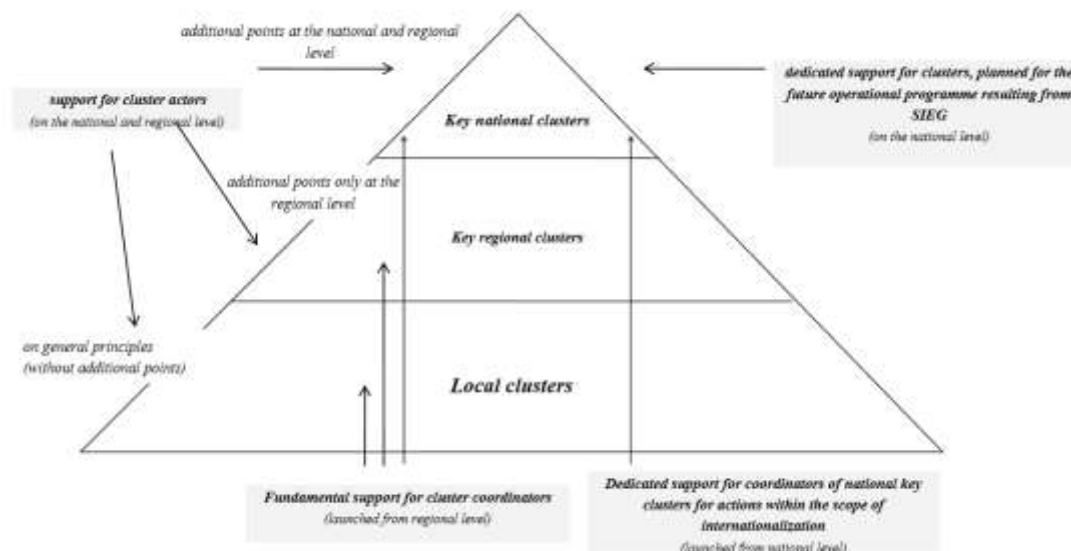


Fig. 1. Map of cluster support in Poland [2].

#### 4 Key National Clusters – a Case of Poland

The cluster policy model based on the support of key clusters is implemented in several national economies. An example is Canada, where only five superclusters have received support lately. In the central part of Europe, two countries, Hungary and Poland, introduced programmes of selection and additional support for clusters relevant to the whole economy. In Hungary, the government created the Accredited Innovation Clusters and to be in this group cluster has to operate for at least 3 years, has 20 members as a minimum, 15 of which must operate in the cluster for more than two years, and the small and medium-sized enterprises must represent at least 75% of all the cluster entities. The Czech Republic has not introduced the programme of key clusters' selection, as it decided not to create groups of privileged clusters, believing that the authorities should offer the same opportunities to all the actors. In Slovakia, for the time being, the theoretical fundamentals are being developed, and the clusters crucial to the economy need to meet very specific criteria [6].

In Poland, there are currently 16 key national clusters that have been selected in the national competition (see figure 2). The Organizer of the Competition for the status of the Key National Cluster (KNC) is the Ministry of Development, which runs the Competition in cooperation with the Polish Agency for Enterprise Development (PARP). In the first round of the Competition for KNC status, 22 applications were submitted, on 24 September 2015, the minister competent for economy approved the list of seven Key National Clusters. The call for proposals in the second round of the Competition ended in July 2016, and the Minister of Development approved the list of the next 9 KNC. The third round of the competition is currently open, which will end

at the end of September 2018 and is addressed to those key clusters that lose their key status in 2018.



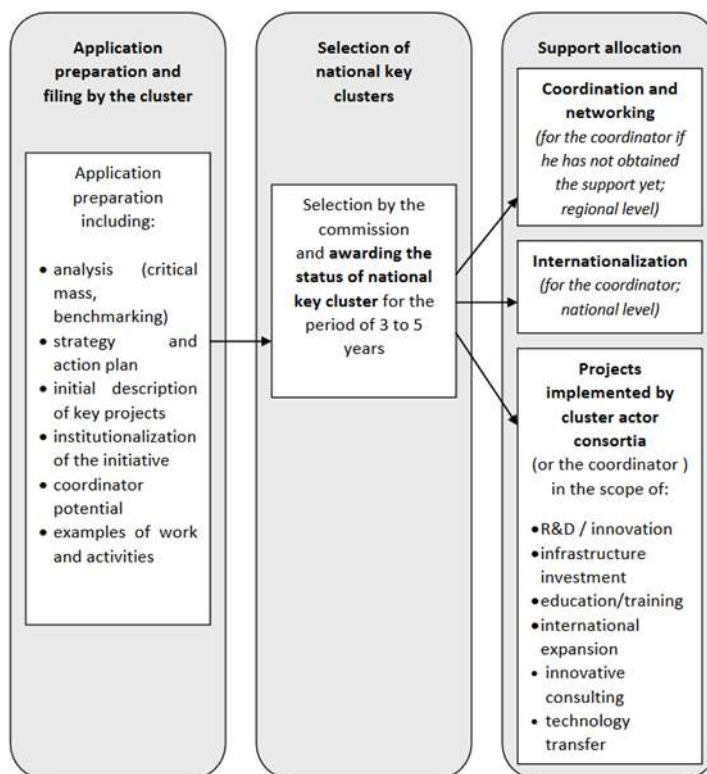
**Fig. 2.** Key National Clusters in Poland (end of September 2018).

Key National Cluster in Poland is a cluster of significant importance for the national economy and high international competitiveness. Key National Cluster is identified at the national level, including based on criteria regarding critical mass, development and innovation potential, past and planned cooperation as well as statement and potential of the coordinator. According to the guidelines of Key National Cluster in Poland, they are characterised by the following features [4]:

- cluster size - at least 51 entities should be gathered in a key cluster, of which 70% should be enterprises. By far the most should be small and medium enterprises, large ones can only be 5, and research units at least 3,
- employment in a cluster - at least 3,000 people should be employed in the cluster,
- members' activity - the cluster should have a formal structure and strategy, the cluster members should provide each other services, and the cluster should have one project co-financed from the EU funds jointly implemented at the time of applying,
- territorial concentration - cluster entities should not be located further away from the coordinator's seat than 150 km,
- cluster specialisation - the cluster is part of the smart specialisation of the country and has a great impact on regional development,

- R & D - the cluster should have completed at least four research projects in the last two years,
- innovativeness - in the cluster, there should be at least three companies like start-up and spin-off, and there should be at least three innovations covered by legal protection introduced,
- financial resources - the cluster should be financed in 30% from private sources,
- internationalization - the cluster should have at least medium activity and recognition on international markets, and the share of exports in the sales structure should be at least 30%,
- cluster management - the cluster should prove at least three years of operation history at the time of application.

The process of identifying and supporting key clusters takes place in three stages (see figure 3). In the first stage, clusters are obliged to carry out detailed analyses, prepare long-term strategies and action plans, describe the activities undertaken and planned, and methods of cluster structure management. In the second stage, the national key clusters are selected, which, after a positive recommendation, receive this status for 3 or 5 years. The last stage in this process, and at the same time the first stage of proper activities supporting clusters, is the allocation of support depending on the cluster's goals and the scope of their operation.



**Fig. 3.** The process of selecting and supporting national key clusters in Poland [13].

## **5 Assessment of Cluster Policy Based on Key Clusters in Poland**

According to the assumptions of the Polish Agency for Enterprise Development, a cluster policy model based on key clusters should bring the following benefits [5]:

- intensified development of clusters - strong, competitive clusters in the international arena,
- intensified development of regions - dominant clusters support the development of regions, industries operating in them, create a culture and develop the entrepreneurial spirit in the region, contribute to the growth of the number of new companies and employment growth and a decline in unemployment,
- smart specialisation - through the selection of the KNC, the specialisation strategy is deepened, the aim of which is to strengthen strong industries that have the best prospects for development in the future. It can, therefore, be assumed that it is a transfer of economic strategies and good business practices to the ground of economic policy, including cluster policy,
- the effectiveness of subsidies - through the distribution of funds among the KNC, it is possible to achieve effective spending of limited funds on the most resilient and promising further development of the enterprise.

The effects assumed in the framework of the Polish cluster policy seem to have economic justification and result from the development strategies recommended by the European Union. On the one hand, these are actions aiming at increasing the scale of development of selected clusters and regions in which they operate, on the other hand, they are too useful in deepening micro and macroeconomic smart specialisation. However, there are a few weaknesses to these assumptions. These are hard to measure benefits, the effectiveness of which will be complicated to evaluate. One of the assumptions is to improve the efficiency of spending funds, which will be directed only to a narrow group of entities. It will certainly be easier to control the flow of funds, as they will reach no more than a dozen recipients at the same time, but the costs of evaluating key clusters also seem to be definitely higher (for example, international recognition will have to be measured on a large group of recipients located in different countries).

As mentioned earlier, there are 16 key clusters in Poland, and most of them are also clusters belonging to the European category of gold, silver or brown clusters. The choice of these clusters within the KNC from among about 130 clusters currently operating in Poland has strengthened already strong Polish clusters, which on the one hand may contribute to the creation of powerful entities competing successfully internationally, but on the other hand, may hamper the development of other clusters in the national economy. A strong focus on only the largest initiatives can lead to a situation in which newly formed clusters, created for example in very modern industries, will not be able to obtain funding for their activities. Therefore their development will be limited due to the use of cluster policy tools. Key clusters receive their status for up to 5 years, which in the dynamically changing global economy and

the international environment may give rise to concerns about the right choice of the industry for financial support. There is, therefore, a justified fear that by selecting key clusters, invests in strong clusters, but not necessarily forward-looking industries.

Another assumption is to strengthen the smart specialisation of regions, which even if they currently show the largest potential growth, then in the future there is no certainty whether this trend will continue.

In Polish cluster policy, the creation of clusters by the top-down method has disappeared, which in many cases led to the creation of artificial clusters, which in the long-term did not have a chance for development. This method in many cases underlies the creation of so-called “wishful thinking clusters”, in which the national or local government is convinced of the possibility of creating a cluster in a given region, which does not evaluate into actual cluster ties. It is necessary to agree with the view presented by Lindqvist, Ketels and Sölvell, who stated „that cluster policy is significantly more likely to be beneficial if it is focused on leveraging rather than creating clusters. In essence, governments lack the knowledge to evaluate where new clusters could emerge in welfare-enhancing ways given the appropriate policy intervention “[10].

When assessing the Polish cluster policy, it should be stated that by conducting recruitment to the key clusters program, it fulfils the recommendations presented in the European Union documents, especially in the Smart Guide to Cluster Policy document from 2016. First of all, it does not only support individual specialised firms, focusing mainly on merging entities or clusters. No new clusters are created, but it supports the strong sides of already existing clusters, offering them a diversified set of support. The policy promotes strategic clusters with development potential, basing their choice on regional competences and smart specialisation. This policy, which should be particularly emphasised, is implemented in conjunction with other policies pursued in the country, such as industrial or innovative policy, mutually complementing.

## **6 Conclusions**

Cluster policy is a set of tools used by the state to support clusters in individual national economies. Two basic assumptions can be made regarding the identification and selection of clusters to support. First of all, cluster policy can support new cluster initiatives that are just being created, and cluster companies do not have a common history of operations. On the one hand, this is an effective measure, as the policy supports new clusters created using the top-down method. On the other hand, it leads to the process of excessive creation of clusters, which are often set up only to obtain financial support from the state. Secondly, cluster policy can support already existing clusters where whose common activity can be documented and which have been successful in joint projects. These clusters were selected to receive much support from the government and can further develop the cluster. In both cases, those clusters that include small and medium enterprises are in the focus of attention [7].

Polish cluster policy is relatively recently introduced, and it rather fulfils the assumptions of European cluster policy, without proposing own innovative tools or solutions. The concept of selecting clusters - leaders in the form of key national clusters,

is to bring about the effect of the better use of funds and building national champions. However, the cluster policy should be looked a bit wider. It should not create a group of entities with privileged access to selected forms of public support, including huge financial, training, marketing and consulting resources. This can lead to huge disproportions between clusters and regions. Already there are regions in Poland where there are three such clusters and regions in which none exist. As a consequence, there will be a deepened specialisation of some regions compared to others, which will be influenced by the policy and not the market. Cluster policy based on key clusters is currently observed a trend in the cluster policy of various countries, but it is not free from defects, and its effects will be difficult to measure.

## References

1. Borrás, S., Tsagdis, D.: Cluster policies in Europe, Edward Elgar Publishing, Cheltenham (2008).
2. Dzierżanowski, M. (ed.): Directions and assumptions of Polish cluster policy until 2020 Recommendations of the Working Group for Cluster Policy, Warsaw (2012).
3. Europe 2020: A European strategy for smart, sustainable and inclusive growth, Brussels, 3.3.2010 COM (2010) 2020.
4. Hołub-Iwan, J., Wielec, Ł.: Opracowanie systemu wyboru Krajowych Klastrow Kluczowych, Część I: Charakterystyka Krajowego Klastra Kluczowego w oparciu o analizę źródeł wtórnych, Polska Agencja Rozwoju Przedsiębiorczości, Warszawa (2014).
5. Hołub-Iwan, J., Wielec, Ł.: Opracowanie systemu wyboru Krajowych Klastrow Kluczowych, Część II: Opis systemu wyboru Krajowych Klastrow Kluczowych w Polsce, Polska Agencja Rozwoju Przedsiębiorczości, Warszawa (2014).
6. Jankowiak, A.H.: Cluster Policy Models in the VISEGRAD Group Countries – A Comparative Study, w: Transformations in Business & Economics, vol. 17, nr 2A, (2018).
7. Jankowiak, A.H.: Industrial clusters as an important factor for development of micro, small and medium-sized enterprises (MSMEs), International Days of Statistics and Economics, Conference Proceedings, T. Löster, T. Pavelka (eds.) Libuše Macáková, Melandrium, (2018).
8. Konstantynova, A., Wilson, J.: Comparing Cluster Policies: An Analytical Framework, Okestra - Working Paper Series- R01:1-33, Basque Institute of Competitiveness (2014). [5]
9. Lehmann, E.E., Menter, M.: Public cluster policy and performance, Technol Transf (2018) 43: 558. DOI:10.1007/s10961-017-9626-4.
10. Lindqvist, G., Ketels, Ch., Sölvell, Ö.: The Cluster Initiative Greenbook 2.0., Ivory Tower Publishers, Stockholm (2013).
11. Nishimura, J., Okamuro, H.: Subsidy and networking: The effects of direct and indirect support programs of the cluster policy, Research Policy Volume 40, Issue 5, June 2011, Pages 714-727, DOI: 10.1016/j.respol.2011.01.011.
12. Njøs, R., Jakobsen, S.-E., Wiig Aslesen, H., Fløysand, A.: Encounters between cluster theory, policy and practice in Norway: Hubbing, blending and conceptual stretching, European Urban and Regional Studies, vol. 24, 3: 274-289 (2017), DOI 10.1177/0969776416655860.
13. Park, S.C.: The Fourth Industrial Revolution and implications for innovative cluster policies, AI & Soc (2018) 33: 433. DOI:10.1007/s00146-017-0777-5.



14. Polozhentseva, Y., Klevtsova, M.: Instruments of Development of Cluster Policy: Stages, Models, International Practice, *Procedia Economics and Finance* Volume 27, 2015, Pages 529-537, DOI: 10.1016/S2212-5671(15)01029-1.
15. Smart Guide to Cluster Policy, European Union, 2016, Ref. Ares (2016)2507138 - 31/05/2016.
16. Strategia Rozwoju Kraju do 2020, Warszawa (2012), <http://ww.mrr.gov.pl>, last access 2018/09/25.

## Factors Influencing Investors' Decisions in Polish Companies as Demonstrated by RFID Systems

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**Abstract** The main objective of this paper is to identify, from a theoretical as well as empirical standpoint, factors preferred by managers when making investment decisions in the field of the RFID (Radio Frequency IDentification) technology. Therefore, the paper is aimed at determining factors which are the most significant for decision makers in Polish enterprises. What can be inferred from the research is that key priorities indicated by Polish managers included: features of the new product, its attractiveness and quality along with implementation costs, price and return on investment (ROI). Managers with greater experience in implementing innovations and using RFID systems differed from inexperienced ones as they appreciated the advantages of the new product and represented a more optimistic investment approach. Managers with less experience in the implementation of innovation and RFID systems, despite perceiving the advantages of the system in question, were concerned with the cost and risk pertinent to investment decisions. During the research, the social survey method was used; applied the form survey examined 203 Polish managers. Were employed the Pearsons' Chi-Square and the Kruskal-Wallis ANOVA tests and relationships between qualitative and mixed characteristics were identified.

**Keywords:** Decision Making Factors, Investment Decisions, Radio Frequency Identification (RFID).

### 1 Introduction

This study discusses factors relevant for Polish managers in the decision-making process related to investing in an innovative RFID system. "Radio frequency identification (RFID) is a wireless, automatic authentication and data capturing technology [10]". Main components of RFID technology include an RFID transponder and an RFID reader, connected with a computer system. The development of RFID technology arouses interest among managers of businesses, mainly in industries such as: FMCG, transport, logistics, large retail establishments and medical industry. "In general, organizations implement RFID to enhance product visibility, [obtain] accurate and real time data, and sustainable competitive advantage [10]".

Findings reported in studies presented in this work are related to potential decisions to implement an innovative – and as yet commercially unavailable – RFID system with

an autonomous semi-passive RFID transponder. Such transponders constitute another stage in the evolution of automatic identification of objects. They may utilize various mechanisms such as obtaining energy from environment (e.g. from the electromagnetic field), and processing, storing and using it to perform additional functions (e.g. sensor functionality). This requires that batteries are replaced with another power source (e.g. a supercapacitor). Consequently, they are battery-free devices. An RFID transponder combines the strengths and eliminates weaknesses of a battery-powered semi-passive RFID transponder. Unique technical capabilities in automatic object identification, reliability and the lack of equivalent solutions dedicated to business render the new RFID transponder an innovative product [11]. If an investor implemented an RFID system with such transponders, he or she would be able to provide the customer with access to data on ambient conditions (e.g. humidity, temperature, pressure, light intensity and acceleration) to which a given commodity was subjected over a selected period of time. The results of such measurements would be stored in the RFID transponder's internal memory. Such information would be of benefit not only to the customer but also the owner of the RFID system (i.e. the investor). Documented resources on logistic, storage, transport, production and other processes at work in the organization will be used to further improve such processes.

The main purpose of the studies presented in this paper is to determine factors of greatest significance for Polish business owners when making investment decisions, with particular focus on RFID systems. The following research thesis was formulated: the hierarchy of factors significant for making investment decisions depends on Polish managers' experience in investing in RFID technologies.

## 2 Literature Review

Publications enumerate key factors affecting decisions to invest in RFID in a company, including demand forecasts, determining product availability in stock, waste reduction, increase in sales, boosting supply chain effectiveness, as well as information transparency and accuracy [11]. Other studies isolate various factors which influence decisions related to investing in RFID such as: regulatory (e.g. security issues, environmental pressure, patent and copyright regulation), operational (e.g. accurate and real time information, product visibility, sustainable competitive advantage) and other (e.g. implementation cost, regulatory legislation, technological complexity, benefit trade-off) [10]. According to other research results "The technological factor is statistically significant across all regions, including North America, Europe and Asia. The organizational factor is significant only in developing countries like Southeast Asian countries and East Asian countries. Environmental factors like government intervention for facilitating RFID adoption are strong enough only in Southeast Asia and Europe [7]". In the case of medical organizations important factors of investment decision making (in RFID area) include "effectively managing and tracking medical equipment, monitoring and identifying patients, ensuring that the right medication is given to the right patient, and preventing the use of counterfeit medicine [9]". When making investment decisions it is crucial to take into account implementation steps such

as project scoping, analysis of the existing system, system design, prototype testing, implementation and continuous improvement. Moreover, some critical success factors: technological (selection of appropriate hardware and software, effective testing, sufficient technical support, clear process, data routine and clear performance measures), managerial (clear vision and good project management skills) and social (teamwork and effective communication) have also been identified [8].

The remaining part of the present work concerns investment decisions by Polish managers in collaboration with a team of researchers (from Department of Electronic and Telecommunications Systems, Faculty of Electrical and Computer Engineering, Rzeszów University of Technology), who developed an innovative RFID system with an autonomous semi-passive RFID transponder. The design and implementation of such system required the completion of many stages and making multiple closely related scientific, technical and managerial decisions, i.e.:

- analysis of requirements – practical assessment of implementation problems [2],
- designing system architecture, modelling – creating a mathematical model of the RFID system to automate the selected object identification process [5],
- design, programming, integration – defining mandatory system parameters and RFID devices for their reliable operation [1, 4],
- tests – preparing device demonstrators and experimentally verifying the operation of the RFID system being designed by means of such demonstrators [3, 6],
- prototyping and implementation – making RFID device prototypes intended for implementation in the company and participation in the commercialization phase,
- in the stages preceding, an assessment of conditions determining managers' decisions is necessary – i.e. market potential analysis, as well as studying the commercialization capability of the new product, an RFID system with an innovative RFID transponder [12].

In the above process, researchers are partnered by RFID system manufacturers (suppliers) and businesses implementing the RFID system (recipients). Each implementation of the RFID system in a company will constitute a separate, complex and risky process, necessitating cooperation between many stakeholders and many prospective decisions based on multiple criteria in significant risk conditions. Similar projects and studies are nowadays conducted worldwide; however, further in this paper we presented only the achievements of the team of scientists from Rzeszów.

### 3 Method

A social survey described in Table 1 was conducted for the purpose of the study.

**Table 1.** Research characteristics.

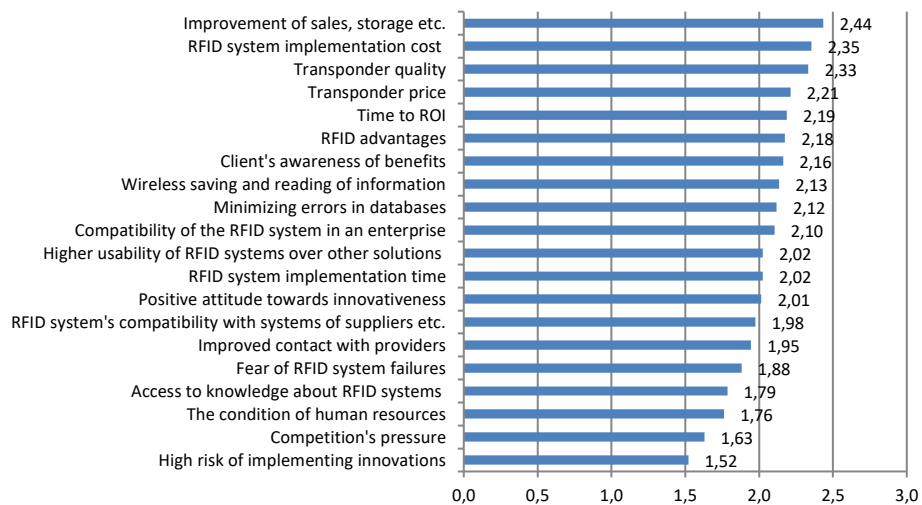
Research scope	Research description
Scope of research presented	Factors determining investment decisions in the field of RFID technology

Research tool	Questionnaire form
Research time frame	Four months – from 5 November 2014 to 5 February 2015
Population studied	Polish company managers from the top- and middle-management
Test sample selection criteria	Availability of respondents selected according to the type of business in which an RFID system with an autonomous semi-passive RFID transponder could potentially be used
Test sample size	A total of 203 managers' opinions were analysed
Types of businesses managed by subjects	According to criteria: sector (production – 34%, trade – 28% services – 28 %, and 14% – mixed business activities); scale of operations (47% – international, 15% – national, 18% – regional and 19% – local); legal and organizational form (47% – limited liability companies, 18% – joint-stock companies, 10% – general partnerships, 9% – registered partnerships and others); capital (59% – Polish and 41% – foreign)
Questionnaire form description	Questions (5 pages) concerning factors determining decision-making in the process of an RFID system implementation with an autonomous semi-passive RFID transponder; company information (1 page); an attachment (2 pages) containing an information sheet about automated object identification, autonomous semi-passive RFID transponder and typical applications of RFID systems
Research procedure description	500 colour copies of questionnaires were printed and handed over to managers all over Poland at trade fairs, scientific conferences and directly on company premises. Moreover, an electronic version of the questionnaire was made available for download on an Internet page and sent to managers via e-mail. The questionnaire was anonymous
Return of questionnaires	The managers filled in 203 questionnaires. 171 completed original questionnaires were returned (34% of all distributed); also, respondents filled in 32 questionnaires in an electronic form downloaded from the webpage containing research project description
Statistical analysis description	The following tests were employed: Pearsons' Chi-Square ( $\chi^2$ ) and the Kruskal-Wallis ANOVA. Relationships between qualitative and mixed characteristics were identified. The research was conducted with the help of Statistica 10. PL and Excel 10 software

The primary objective of the study was to determine factors most significant for managers of Polish companies in making investment decisions, with particular emphasis on an RFID system with an autonomous semi-passive RFID transponder. Detailed study objectives involved determining statistically significant differences (if any) between the significance of individual factors for managers with high and low experience in the matter, i.e. those who had implemented innovations and those had not; in addition – managers who had implemented an RFID system and those who had not implemented such a system.

## 4 Results

Twenty factors were selected in the study. Mean score indicating the significance of such factors for managers when making investment decisions on the implementation of an RFID system with an autonomous semi-passive RFID transponder in their company is shown in Figure 1.

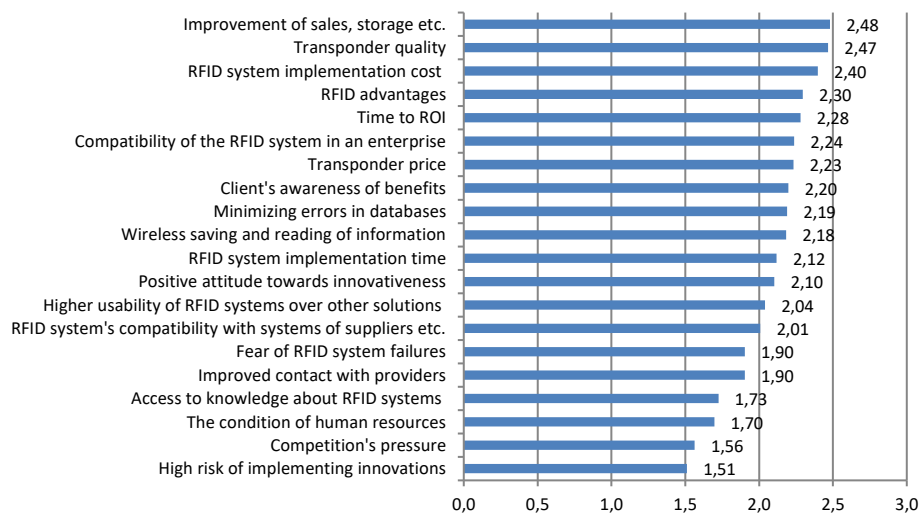


**Fig. 1.** Mean assessment of the significance of 20 selected factors for managers during the implementation of an RFID system in the company.

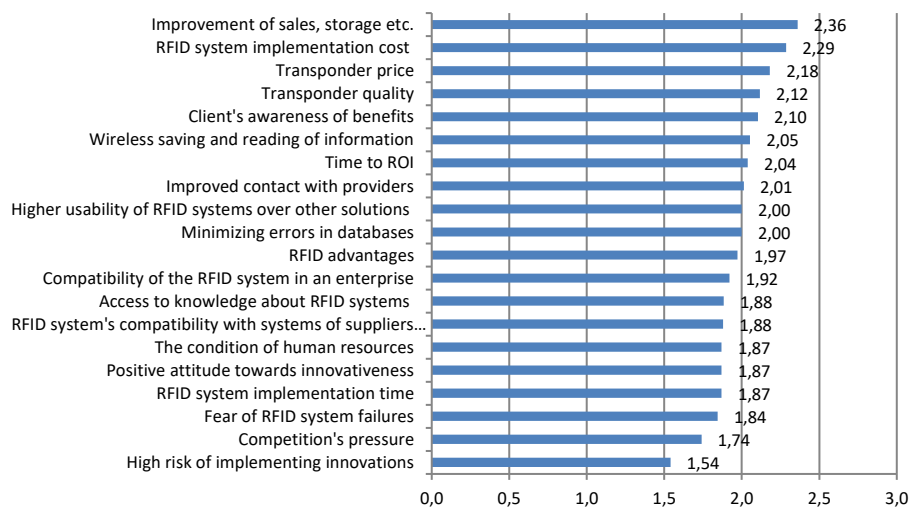
Highest potential impact on the decision to implement the RFID system in question by the subjects was exerted by three factors such as: various process improvements concerning e.g. sales, storage or transport (2.44), RFID system implementation cost (2.35) and transponder quality (2.33).

For managers who had already **implemented innovations** (Fig. 2) in their companies over the past 2 years, the most significant factors included: streamlined sales processes (2.48), transponder quality (2.47) and RFID system implementation cost (2.40).

Managers who **had not implemented innovations** (Fig. 3) also ranked streamlined sales processes the highest (2.36). As the second most significant factor they named RFID system implementation cost (2.29), with RFID transponder price as the third most significant factor (2.18).



**Fig. 2.** Scores awarded by managers who implemented innovations.



**Fig. 3.** Scores awarded by managers who did not implement innovations.

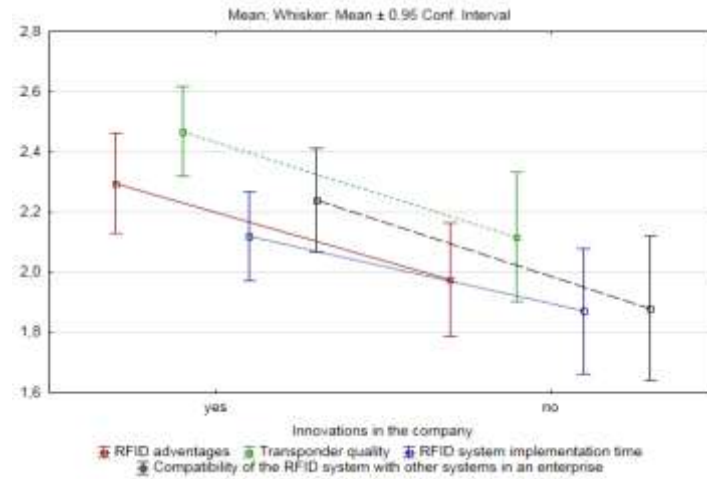
Tests were also carried out to identify differences in the assessment of the significance of individual factors both for managers of companies which had introduced innovations over the past two years and those which had not introduced innovations (Table 2).

**Table 2.** Factors divided according to businesses which implemented innovations and those which did not implement innovations – results of the Kruskal-Wallis ANOVA test.

Factors of significance to managers when making investment decisions on the implementation of an RFID system with an autonomous semi-passive RFID transponder in their company	Innovation implementation		<i>p</i>
	No	Yes	
Wireless saving and reading of information	2.05	2.18	0.366
Advantages of the RFID system (e.g. automatic saving and reading of data, objects identification and real-time information flow, no batteries)	1.97	2.30	0.014*
Transponder price	2.18	2.23	0.702
Transponder quality	2.12	2.47	0.006**
RFID system implementation cost	2.29	2.40	0.361
RFID system implementation time	1.87	2.12	0.049*
Time to ROI in the RFID system	2.04	2.28	0.067
Competition's pressure	1.74	1.56	0.228
Positive attitude towards innovativeness and entrepreneurship	1.87	2.10	0.055
Improvement of sales, storage, transport, administrative and other processes	2.36	2.48	0.340
Client's awareness of benefits (improved service quality and satisfaction)	2.10	2.20	0.496
RFID system's compatibility with systems used by suppliers and	2.01	1.90	0.440
High risk of implementing innovations	1.54	1.51	0.836
Compatibility of the RFID system with other systems in an enterprise	1.88	2.24	0.014*
RFID system's compatibility with other systems used by suppliers and recipients	1.92	2.01	0.582
Fear of RFID system failures during the initial stage after implementation	1.84	1.90	0.662
Access to knowledge about RFID systems	1.88	1.73	0.240
Minimizing errors in databases by implementing the RFID	2.00	2.19	0.162
Higher usability of RFID systems over alternative solutions	2.00	2.04	0.769
The condition of human resources – its knowledge, qualifications, openness to change etc.	1.87	1.70	0.175

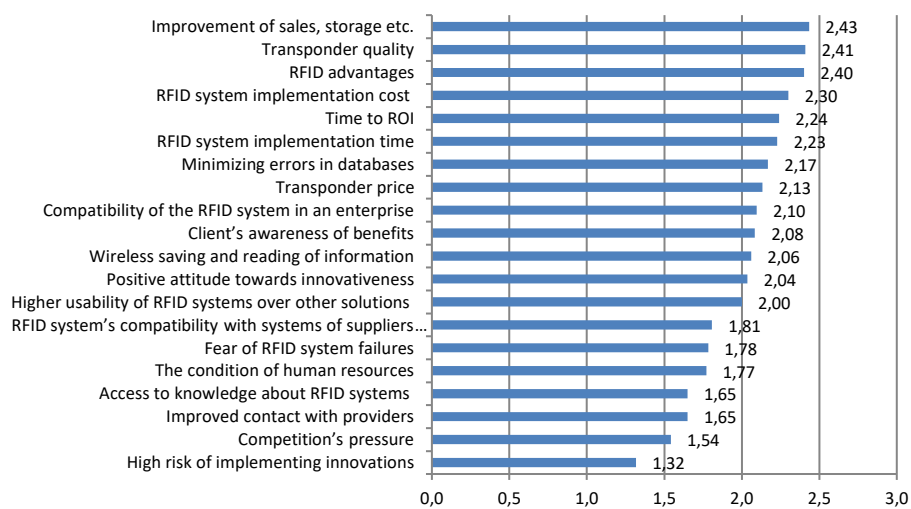
The analysis allows us to conclude that statistically significant difference in the assessment of the importance of analysed factors was present in the following cases: RFID system's advantages  $p < \alpha$  ( $p=0.014$ ), RFID transponder quality  $p < \alpha$  ( $p=0.006$ ), RFID system implementation time  $p < \alpha$  ( $p=0.041$ ) and RFID system's compatibility with other systems in the company  $p < \alpha$  ( $p=0.014$ ).





**Fig. 4.** Means interaction graph: innovations and the RFID system.

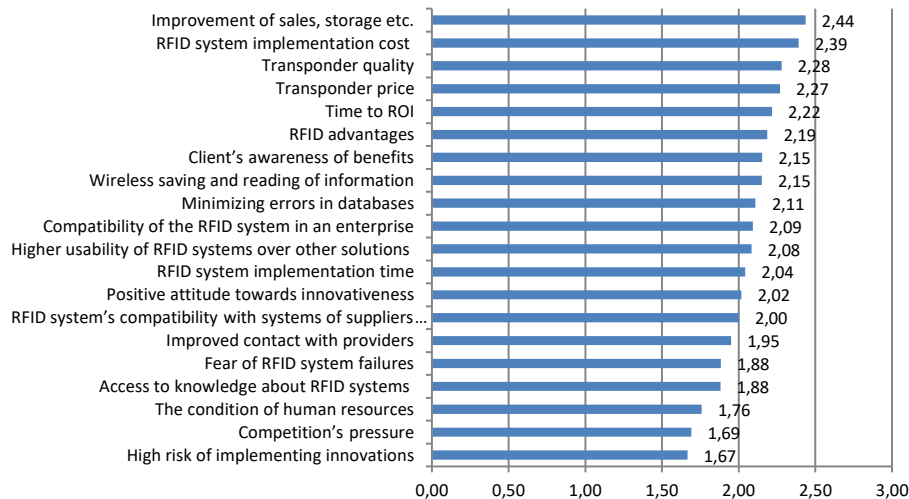
The means interaction graph (Fig. 4) shows that managers of companies in which innovations had repeatedly been introduced over the past two years gave higher scores than managers without such experience to: RFID system's advantages, RFID transponder quality, RFID system implementation time and RFID system's compatibility with other systems in the business.



**Fig. 5.** Scores awarded by managers in businesses with RFID system(s).

It was also verified how the analysed factors were assessed by managers who already had some kind of RFID system in their company and those who did not have such a

system. Managers **in possession of RFID system(s)** (Fig. 5) awarded highest scores to: streamlined sales processes (2.43), transponder quality (2.41) and benefits of the RFID system (2.40). Managers in companies **without an RFID system** (Fig. 6) gave the highest scores to: process improvements (2.44), RFID system implementation cost (2.39) and RFID transponder quality (2.28).



**Fig. 6.** Scores awarded by managers in businesses without an RFID system.

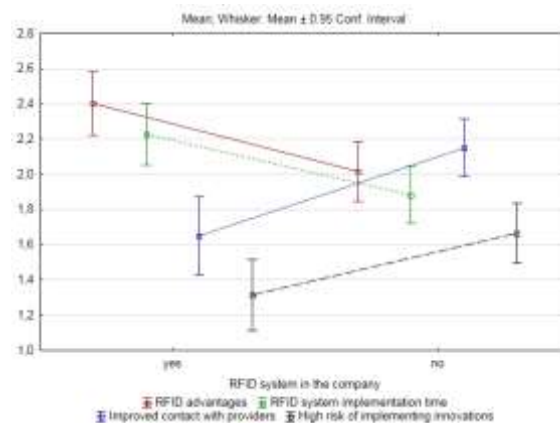
It was also verified (Tab. 3) whether the possession of any RFID system in the company influenced the assessment of the significance of individual factors.

**Table 3.** List of factors according to companies which had an RFID system and those which did not use any RFID system – results of Kruskal-Wallis ANOVA test.

Factors of significance to managers when making investment decisions on the implementation of an RFID system with an autonomous semi-passive RFID transponder in their company	RFID system implementation		<i>p</i>
	Yes	No	
Wireless saving and reading of information	2.06	2.19	0.369
RFID advantages (e.g. automatic saving and reading of data, objects identification and real-time information flow, no batteries)	2.40	2.02	0.003**
Transponder price	2.13	2.27	0.291
Transponder quality	2.41	2.28	0.312
RFID system implementation cost	2.30	2.39	0.451
RFID system implementation time	2.23	1.88	0.005**
Time to ROI in the RFID system	2.24	2.15	0.492
Competition's pressure	1.54	1.69	0.302
Positive attitude towards innovativeness and entrepreneurship	2.04	2.00	0.764
Improvement of sales, storage, transport, administrative and other processes	2.43	2.44	0.986

Factors of significance to managers when making investment decisions on the implementation of an RFID system with an autonomous semi-passive RFID transponder in their company (cont.)	RFID system implementation		<i>p</i>
	Yes	No	
Client's awareness of benefits (improved service quality and satisfaction)	2.08	2.22	0.334
Improved contact with providers	1.65	2.15	0***
High risk of implementing innovations	1.32	1.67	0.009**
Compatibility of the RFID system with other systems in an enterprise	2.10	2.11	0.924
RFID system's compatibility with systems used by suppliers and recipients	1.81	2.09	0.066
Fear of RFID system failures during the initial stage after implementation	1.78	1.95	0.218
Access to knowledge about RFID systems	1.65	1.88	0.080
Minimizing errors in databases by implementing the RFID system	2.17	2.08	0.529
Higher usability of RFID systems over alternative solutions	2.00	2.04	0.752
The condition of human resources – its knowledge, qualifications, openness to change etc.	1.77	1.76	0.918

Statistically significant differences were detected in four cases: RFID system's advantages  $p < \alpha$  ( $p=0.003$ ), RFID system implementation time  $p < \alpha$  ( $p=0.005$ ), streamlined contact with suppliers  $p < \alpha$  ( $p=0$ ) and high innovation implementation risk  $p < \alpha$  ( $p=0.009$ ).



**Fig. 7.** Means interaction graph concerning RFID system operation and its factors as well as innovation risk.

The means interaction graph (Fig. 7) shows that managers of companies which operated an RFID system ranked its advantages and implementation time higher. Managers whose companies did not have any RFID system attached greater importance to streamlined contact with suppliers and high risk of implementing innovations.

## 5 Conclusions

The purpose of this paper was to identify factors preferred by investors in the field of RFID technology. Accordingly, the following factors of **greatest importance to decision-makers in Polish businesses** were identified: various process improvements, RFID system implementation cost, transponder quality, RFID transponder price and time to ROI (similar results were obtained by: [7, 8, 9, 10, 11, 12]). It appears that managers' priorities include decision-making criteria related to product value, i.e. the attractiveness and quality of the product, and also to the cost of its implementation, its price and return on investment. In the survey, managers named the above factors as most important ones, with knowledge and risk ranked lower. For **experienced managers, who had implemented innovations in their businesses**, most significant factors included: streamlined sales processes, RFID transponder quality and RFID system implementation cost; for managers without such experience: streamlined sales processes, RFID system implementation cost and RFID transponder price. Statistically significant differences in the assessment of the analysed factors were present in four cases – experienced managers in companies which had introduced innovations awarded higher scores than managers without such experience to: RFID system's advantages, RFID transponder quality, RFID system implementation time and RFID system's compatibility with other systems in the business. The conclusion that could be drawn from the analysis of the above findings is that experienced managers, in contrast to inexperienced ones, pay more attention to product value than its implementation costs. The results may also suggest that managers who did not implement innovations in their company were limited by insufficient financial resources.

**Experienced managers who had implemented RFID system(s) in the company** assessed the following as the most significant: streamlined sales processes, transponder quality and RFID system's advantages; inexperienced ones most frequently indicated process improvements, RFID system implementation cost and RFID transponder quality. A statistically significant difference was found with respect to four factors – experienced managers ranked system advantages and system implementation time higher than inexperienced managers, with streamlined supplier contacts and risk of implementing innovations receiving lower scores than in the case of managers with less experience. Managers with considerable experience in operating RFID systems clearly appreciated many advantages of such systems and value of the new product (RFID transponder); in addition, RFID system implementation time, significant in gaining competitive advantage, was also an important factor for them. Managers without experience with an RFID system in their companies, in addition to the advantages of such system, emphasized factors such as cost, risk and relations with suppliers. Experience in the field of RFID technology clearly resulted in increased optimism in investment plans and priorities.

**Acknowledgements.** This work was supported in part by the Polish National Centre for Research and Development (NCBR) under Grant No. PBS1/A3/3/2012 titled

“Synthesis of autonomous semi-passive transponder dedicated to operation in anticollision dynamic RFID systems”.

## References

1. Jankowski-Mihułowicz, P., Kalita, W.: Application of monte carlo method for determining the interrogation zone in anticollision radio frequency identification systems. In: C. Turcu (ed.), *Current Trends and Challenges in RFID*, chapter 17, pp. 335–356. INTECH, Croatia (2011), DOI: 10.5772/20736.
2. Jankowski-Mihułowicz, P., Kalita, W., Pawłowicz, B.: Problem of dynamic change of tags location in anticollision RFID systems. *Microelectronics Reliability* 48(6), 911–918 (2008), DOI: 10.1016/j.microrel.2008.03.006.
3. Jankowski-Mihułowicz, P., Kalita, W., Skoczylas, M., Węglarski, M.: Modelling and design of HF RFID passive transponders with additional energy harvester. *International Journal of Antennas and Propagation*, Article ID 242840, 1–10 (2013), DOI: 10.1155/2013/242840.
4. Jankowski-Mihułowicz, P., Węglarski, M.: Determination of passive and semi-passive chip parameters required for synthesis of interrogation zone in UHF RFID systems. *Electronics and Electrical Engineering* 20(9), 65–73 (2014), DOI: 10.5755/j01.eee.20.9.5007.
5. Jankowski-Mihułowicz, P., Węglarski, M.: Interrogation zone determination in HF RFID systems with multiplexed antennas. *Archives of Electrical Engineering* 64(3), 459–470 (2015), DOI 10.2478/aee-2015-0035.
6. Jankowski-Mihułowicz, P., Węglarski, M., Pitera, G., Kawalec, D., Lichoń, W.: Development board of the autonomous semi-passive RFID transponder. *Bulletin of The Polish Academy of Sciences Technical Sciences* 64(3), 647–654 (2016), DOI: 10.1515/bpasts-2016-0073.
7. Reyes, P.M., Li, S., Visich, J.K.: Determinants of RFID adoption stage and perceived benefits. *European Journal of Operation Research* 254, 801–812 (2016), DOI: 10.1108/APJIE-12-2016-010.
8. Ting, S., Tsang, A., Tse, Y.: A framework for the implementation of RFID systems. *International Journal of Engineering Business Management* 5(9), 1–16 (2013), DOI: 10.5772/56511.
9. Ting, S.L., Kwok, S.K., Tsang, A.H., Lee, W.B.: Critical elements and lessons learnt from the implementation of an RFID-enabled healthcare management system in a medical organization. *Journal of Medical Systems* 35(4), 657–669 (2011), DOI: 10.1007/s10916-009-9403-5.
10. Vishvakarma, N.K., Sharma, R.R.K.: Key RFID implementation factors affecting “sourcing” decision of RFID systems in supply chain of manufacturing industry. *Proceedings of the 2016 International Conference on Industrial Engineering and Operations Management*, pp. 1537–1547. IEOM Society International, Kuala Lumpur (2016).
11. Vlachos, I.P.: A hierarchical model of the impact of RFID practices on retail supply chain performance. *Expert Systems with Applications* 41(1), 5–15 (2014), DOI: 10.1016/j.eswa.2013.07.006.
12. Ziółkowski, B., Piecuch, T., Jankowska-Mihułowicz, M., Chudy-Laskowska, K.: Development of RFID systems in enterprises. Research results based on the Delphi method. *Oficyna Wydawnicza Politechniki Rzeszowskiej*, Rzeszów (2016).

## Collaborative Consumption Impact on Tourism Growth and Sustainable City Development

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**Abstract.** Collaborative consumption (CC) is discussed in terms of its role in the implementation of sustainable development goals. The objective of the paper is to present the role of collaborative consumption in tourism growth and the sustainable cities development. The purpose of the article was achieved as the result of review and critical analysis method application (especially in the course of the first and second stage of the study) and SALSA method application (at all stages). The deduction and research results synthesis methods were also applied. The paper presents the nature of collaborative consumption and the impact of CC platforms on the raise of tourism traffic (using the example of Airbnb as the biggest player on the accommodation sparing market). Further, the views of different researchers on the idea of sustainable city are presented as well as its interpretation in the light of Agenda 2030. Deliberating tasks of Agenda 2030 connected with sustainable cities, the paper attempts to describe directions of impact of CC in tourism on sustainable development of cities. The conclusion part offers the pack of the most important features of collaborative consumption in tourism for sustainable city development.

**Keywords:** Collaborative Consumption, Sustainable Development, Tourism, City.

### 1 Introduction

Collaborative consumption, also referred to as sharing economy, collaborative economy, hybrid economy and peer-to-peer [7, 8, 9 13, 18] represents one of the most important current megatrends [11] in tourism. The increasing number of tourist needs are satisfied within this particular formula. There are both strictly tourist needs (such as: transport, accommodation, food, sightseeing etc.) and the complementary ones (e.g. taking care of the house abandoned as a result of taking the trip, looking after the family members or pets left behind etc.) among them. A relatively rapid increase in collaborative consumption in tourism is forecasted predominantly in terms of accommodation in private houses and renting private cars [24]. PwC estimates that in Europe peer-to-peer accommodation is the largest sector of the collaborative economy with an estimated total transaction value of €15.1 million in 2015 [10].

More and more publications that discuss the problem of collaborative consumption refer to its multifaceted nature, manifold external effects as well as its multidimensional interactions. Collaborative consumption (CC) is also discussed in terms of its role in the implementation of sustainable development goals [3, 4, 5, 14, 20, 23, 26, 27, 33]. The aforementioned authors focus primarily on the positive impact of collaborative consumption on the formation of three sustainable development dimensions. The observation of tourism market, however, provides numerous examples of negative impact exerted on the overall economy by sharing economy, society and natural environment. However, both market practice as well as scientific debate also present several examples of negative impact caused by CC.

## 2 The Objective and Research Methodology of the Paper

The objective of the paper is to present the role of collaborative consumption in tourism growth and the sustainable cities development. The research process uses a three stages procedure, embracing:

1. The characteristic of collaborative consumption in tourism.
2. The changes in tourism traffic in cities through CC platforms – example of Airbnb.
3. The identification of Impacts of Collaborative Consumption on Sustainable City Development in the light of Agenda 2030.

The aim of the paper has been achieved as the result of use of review and critical analysis methods (especially in the course of the first and second stage of the study) and SALSA method application (at all stages). The deduction and research results synthesis methods were also applied.

Their selection was based on applying the above-mentioned SALSA analytical framework (Search, Appraisal, Synthesis and Analysis) [22]. *Search* – the analysis of terminology used in published literature, which resulted in determining such terminology, i.e. the key words, and next specifying the selection criteria for research publications analysis. The following key words were distinguished: collaborative consumption, sharing economy, tourism, CC platforms, sustainable city. The following criteria were adopted as fundamental for the selection of the underlying research works: the recognized scientific publishers (e.g. AMA, Collins, Elsevier, Emerald, Harvard, Routledge, Wiley), the availability of publications (physical or virtual), the positioning in search engines and the number of quotations. Within the next stage of SALSA (*Appraisal*) procedure the assessment of publications was conducted, in terms of the above-mentioned key words, based on their abstracts analysis. The performed synthesis allowed for choosing these literature references which met all the selection criteria and thus the analysis has taken into account 24 compact publications and research articles. Among the key ones the most important were Dolnicar's [9] and Botsman & Rogers' [5, 6, 7] publications. Another very important document is the 2030 Agenda for Sustainable Development, which points 17 goals which will stimulate action over the next fifteen years in areas of critical importance for humanity and the planet. Among them there are targets for sustainable cities.

### **3 Understanding Collaborative Consumption: Delimiting the Notion**

Sharing is an idea as old as time itself; still the sharing economy and collaborative consumption are phenomena popularized in the Internet era [4]. Internet services based on user-generated content such as Facebook and Instagram encourage individuals to share in differentiated ways. Consumer-to-consumer vacation rentals and ride share bulletin boards have been around for years, but efficient online payments and trust in e-commerce have made sharing a viable alternative for the mainstream. Startups like Airbnb, Carpooling and Blablacar have enjoyed tremendous growth. They now operate on such a scale that they are catching mainstream hotels and transportation companies in convenience, and usually beating them on price. Now, the collaborative economy concept has emerged in the tourism marketplace and businesses based on the sharing economy concept continue to grow at a phenomenal pace [15]. Apart from using the collaborative consumption concept, this phenomenon is also referred to using terms from the set of IT terminology (the mesh, peer-to-peer consumption), sociological terminology (connected consumption, access-based consumption) and economic one (sharing economy, collaborative economy, owner-less economy, non-ownership economy, access-based economy) [7]. All metaphors used in the above mentioned terms have their own significant information load and emphasize the important differentiating aspects of the collaborative consumption phenomenon. IT specialists underline the relationship and strong dependence of its formation on the development of information and communication technology (ICT). Sociologists focus on consumption methods and their lasting as well as development oriented nature, approaching collaborative consumption as a technical and social trend. Economists, however, in their definitions notice the significant impact of collaborative consumption on other management processes, i.e. production, distribution and exchange. The sharing economy concept has created markets out of things that were not regarded as monetizable properties before [12]. The emergence of profit-based online platforms for the peer-to-peer (P2P) sharing of consumer goods and services provides new ways for end-users to generate income from their possessions. However, Geron stated that the role of P2P sharing in increasing personal profits as a wage market becomes stagnant is vanishing and it is being transformed into a disruptive economic force [12]. The development of profit-based online platforms for P2P sharing such as Airbnb, has influenced the way people travel and is of great importance to the traditional tourism industry [15].

When considering the ‘sharing economy’, a crude distinction can be drawn between two narratives employed by policy-makers, commentators, entrepreneurs, critics and activists [19]. First, there is a narrative that reflects the development of a market-based digital innovation with enough potential to disrupt established business models and generate economic activity, and, as a consequence, can result in incidental social and environmental benefits [24, 31]. This perspective has been strongly criticized as a form of “neo-liberalism on steroids” [21] due to the potential of technological innovations within the sharing economy to circumvent environmental and social regulation. For example, sharing economy platforms have been criticized for enabling tax avoidance



and eroding labor rights respectively. Alternative narratives have been constructed around the development of a social innovation, or even a social movement [28], searching to address the inequalities, unsustainability and injustices of free market. Heinrichs [14] has heralded the sharing economy as a potential new pathway to sustainability whilst Botsman and Rogers [6] argue that it will disrupt the unsustainable practices of hyper consumption that drive capitalist economies. Supporters of this point of view also justify such expectations stating that sharing access to services and goods gives the opportunity for much more efficient utilization of resources (from cars to accommodation), which in turn will minimize the scale of economic activity and therefore yield environmental benefits. Furthermore, advocates also argue that sharing access to resources builds social capital (as citizens interact in the process of ‘sharing’), and allows for more equitable distribution of goods and services (as access costs are lower than ownership costs) [19].

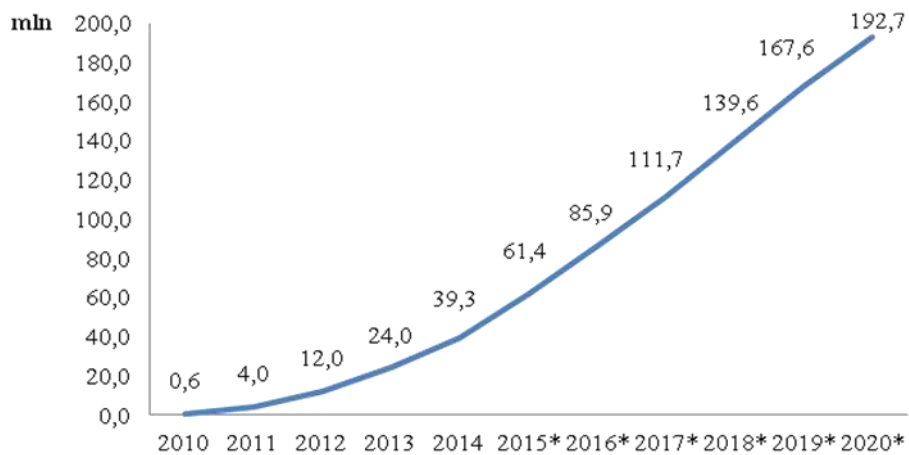
Tourism remains one of the most important areas of development of CC. Accommodation and transportation platform are among the most often researched and the biggest entities that grew up by offering direct combination of customers with suppliers in the sharing economy. The discussion on the essence of collaborative consumption in tourism should take into account the essence of collaborative consumption in general. Taking this approach and considering the most important attributes of collaborative consumption, along with having in mind the specific features of tourism, for the article purposes, collaborative consumption in tourism was defined as follows: the acts of satisfying tourist needs by consumers due to the collaborative usage of a good to which at least one of them is entitled. Currently, such acts are supported by digital platforms functioning as intermediaries in liaison with consumers, which results in negative, apart from positive, effects of CC formation from the perspective of sustainable development goals. Even though CC in tourism is a very big and diverse phenomenon, most of research and press releases are connected with the biggest platform enhancing peer-to-peer relations, i.e. Airbnb in hospitality sector. The size of its operations and the scale of its influence as well as legal controversies makes it very interesting topic of scientific debate.

#### **4 Collaborative Consumption and the Growth of Tourism Traffic in Cities – Example of Airbnb**

Airbnb company was officially registered as a company on August 1, 2008, in San Francisco, USA. From the point of view of the functions it performs on the accommodation services market, it can be assumed that the Airbnb platform is a trading agent in booking and selling mainly accommodation services that associates the exchange parties using an Internet communication link that can be used via stationary and mobile digital devices (e.g. computers, tablets, smartphones). The company describes itself as a ‘trusted community marketplace for people to list, discover and book unique accommodation around the world — online or from a mobile phone or tablet’. As the Airbnb website communicates, the supply of accommodation is available on all continents, in almost all countries of the world and 65,000 cities which are

dominated by metropolitan areas (e.g. San Francisco, New York, Sydney, Barcelona, Paris).

It is estimated that in the first eight years of the company's operation the average annual growth rate of the value analysed varied around 290%. On the other hand, it is anticipated that in the following periods by 2020, these indications will vary around 30% annually, far above the average annual growth rate of the number of rooms booked in the facilities of the largest hotel brands. This high growth rate of the number of reservations can be achieved mainly due to the fast growth rate of cumulative capacity and service capacity of suppliers that sell accommodation via Airbnb. In 2009, 100,000 reservations were made via the Airbnb platform. Two years later, as much as 4 million reservations were made, and forecasts indicate that in 2020, this number may approach 193 million.



**Fig. 1.** The number of room nights booked and estimated to be booked via Airbnb 2010-2020 [8].

The rapidly increasing high growth of number of rooms rented presented above is a result of the rapid growth of Airbnb service potential which is significantly larger than that of the largest competitor, i.e. HomeAway.com, and the largest hotel groups (Marriott, Hilton, Accor). For example, in 2015, as compared to 2014, this increase for Airbnb was 118%, and for the hotel groups it did not exceed 7% [29].

A study conducted between 2012 and 2014 by Airbnb indicates crucial impact on tourism traffic in cities, e.g. [2]:

- 61 percent of Airbnb guests were visiting Barcelona for the first time,
- 63 percent of Airbnb guests say that Airbnb makes them more likely to return to Sydney,
- 27 percent of guests said they would not have come to Paris or stayed as long without Airbnb.

- Additionally, visitors who choose Airbnb accommodations spend more days traveling compared to hotel guests, e.g. (<http://blog.atairbnb.com/economic-impact-airbnb/>):
- the average San Francisco hotel guest visits for 3.5 days, while the average Airbnb guest - for 5.5 days,
- in New York City, Airbnb visitors stay on average for 6.4 nights (compared to 3.9 for hotel guests),
- in Paris, on average Airbnb guests stay for 2.9 nights longer compared to hotels,
- Airbnb guests stayed on average for 3.9 nights, while hotel guests who stay on average for 1.9 nights in Amsterdam,
- in Berlin, on average Airbnb guests stay for 6.3 nights compared to hotel guests who stay on average for 2.3 nights.

These data might indicate that the tourism traffic increases and the increased number of visitors would enhance all economic benefits for a destinations connected with employment and income of public budgets as well as private companies and households. Still, higher overall demand for tourist goods and services in tourist cities and regions could result in exceeding the carrying capacity of a destination. The significantly increased tourist traffic poses a threat on natural environment due to significant increase in pollution emission and waste production, water and energy consumption. Also, the uncontrolled increase in the number of tourists makes monitoring of tourist capacity difficult.

An important research issue related to CC development is spatial distribution of its impact in cities. It is clear that tourist traffic is wider dispersed across the city as a result of spatial dispersion of peer-to-peer accommodation. P2P accommodation is more concentrated in the inner city neighborhood and those closest to tourist precincts and this accommodation type become more dispersed further away from the city centers. There is some merit in the argument that tourists staying outside city centers might spend their time in local grocery stores and cafes and so they distribute the economic impacts of tourism more broadly across the city [10]. Discussing impact of collaborative consumption on the sustainable development of it is necessary though to considerate both positive and negative consequences.

## **5 Impacts of Collaborative Consumption on Sustainable City Development in the Light of Agenda 2030**

A sustainable city has been defined in many ways. The most common understanding is a vision of a city that is able to meet the needs of the present without compromising the ability of future generations to meet their own needs. Two ideas are crucial for this vision: cities should meet social needs, especially the needs of the poor, and they should not exceed the ability of the global environment to meet the future needs [16]. According to Hoornweg [17], a city approach to sustainability would require all urban actors to rally around practical problem solving to address the specific challenges of access to services, to promote integrated and innovative infrastructure design and to

make them resilient to climate change. This is why the Member States of the United Nations have adopted a dedicated goal to make cities and human settlements inclusive, safe, resilient and sustainable as part of the 2030 Agenda [1]. Achieving of that aim should be supported by realization of 10 tasks.

Considering the literature presented in the paper, it possible to state that CC may both enhance and influence negatively on sustainable city development (tab. 1).

**Tab. 1.** Exemplification of positive (+) and negative (-) impact of collaborative consumption in tourism on sustainable development of cities, regarding Agenda 2030 [1].

Targets	Impact of CC in tourism
By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums	<ul style="list-style-type: none"> <li>• Additional source of citizens' incomes (+)</li> <li>• Enhances increase of apartments' prices (-)</li> </ul>
By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons	<ul style="list-style-type: none"> <li>• Leads to decrease in level of prices in hotel sector (+)</li> <li>• Decrease in safety in road traffic (-)</li> </ul>
By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries	<ul style="list-style-type: none"> <li>• Enhances in revitalization of city quarters (+)</li> <li>• Enhances over urbanization of quarters attractive for tourists (-)</li> </ul>
Strengthen efforts to protect and safeguard the world's cultural and natural heritage	<ul style="list-style-type: none"> <li>• Increased spending of tourists on culture (+)</li> <li>• Intensification of tourism traffic in cultural heritage sites (-)</li> </ul>
By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	<ul style="list-style-type: none"> <li>• Increased number of tourists influences negatively the environment (-)</li> </ul>
By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities	<ul style="list-style-type: none"> <li>• Increased number of tourists leads to intensification of green area and public space exploitation which may lead awakening of not desired behavior of tourists and/or citizens. (-)</li> </ul>
Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning	<ul style="list-style-type: none"> <li>• Tourists are often interested not only in city centers but also in attractions located nearby, which requires local authorities creating integrated tourism offer. (+)</li> </ul>

## 6 Conclusions

Among the most important trends that shape the contemporary tourism in cities which is not conspicuous in other tourism destinations are rapid development of CC in tourism and establishment of huge global companies like Airbnb, Homeaway and Couchsurfing as platforms to offer tourism services for collaborative consumption. The issue of CC in tourism gains a lot of interest from the academia still our scientific knowledge about the phenomenon is not grounded, scattered and not following the pace of the development of CC [7, 29]. The topic of sustainability occurs rather often in the context of sharing economy researches which is mirrored in sharing economy's definitions [26]. Still, works that analyze its impact on sustainable development of cities [3, 10, 14, 23, 32] are very rare. However, presented paper represents an original approach to the researching of relations between sharing economy and sustainable city development and statements of Agenda 2030 are used as a benchmark to analyse the goals.

By definition, collaborative consumption in tourism is neither a sustainable option nor an unsustainable option [6, 31]. The results presented in the paper allow to conclude that CC – similarly to mass tourism – can be of either more or less sustainable nature. In the light of sustainable development concept, CC can be sustainable when it is:

- focused on the lifespan quality improvement of both current and future generations by developing proper balance among three types of capital: economic, human and natural,
- quality rather than quantity oriented in terms of the goods consumed and services,
- available for all who wish to travel for tourist reasons, regardless of their economic, social or health status (the so-called “tourism for all”),
- driven by high ecological awareness of tourists and their respect for nature protection principles,
- natural environment pressure on minimum level,
- focused on spiritual experiences, health condition improvement, domestic products and the ones created as a result of sustainable processes in production and supply,
- adjusted to individual needs,
- consumer expenditure optimization oriented,
- circular (based on multiple circulation of resources).

Conducted literature review suggests two important issues. First, the development of CC in cities should be monitored and managed locally and nationally to enhance its positive impacts and to reduce the negative ones. This extremely important taking into consideration Martin's [20] statement that if the collaborative consumption continues along this current development model, it is probably not going to drive a transition to sustainability as after establishment of companies like Airbnb, Uber and the others from limited startups to big global corporations, CC in tourism is nowadays mainly just a business. Additionally, this kind of a necessary management is very difficult as it is hard to show an example of a city where the sufficient system of monitoring of CC in tourism and its impact was implemented. Second, further scientific research of the issue

is necessary. From contemporary research [6, 14, 15] we know what may happen rather than what to expect really when CC grows in a particular city.

## References

1. Agenda 2030, [www.undp.org/content/undp/en/home/sustainable-development-goals.html](http://www.undp.org/content/undp/en/home/sustainable-development-goals.html), last accessed 2018/05/04.
2. Airbnb. <http://blog.airbnb.com/economic-impact-airbnb/>, last accessed 2018/05/21.
3. Albinsson, P.A., Perera, B.Y.: Alternative Marketplaces in the 21st Century: Building Community through Sharing Events. *Journal of Consumer Behaviour*, 114, pp. 303-315. (2012).
4. Belk, R.: You are what you can access: Sharing and collaborative consumption online. *Journal of Business Research*, 678:1595-1600. (2014).
5. Botsman, R., Rogers, R.: Beyond Zipcar: collaborative consumption. *Harvard Business Review*, 8810: pp. 30-30. (2010).
6. Botsman, R., Rogers, R. 2010b: What's mine is yours: how collaborative consumption is changing the way we live. London, Collins.
7. Botsman, R.: The Sharing Economy Lacks A Shared Definition. <http://www.fastcoexist.com/3022028/the-sharing-economy-lacks-a-shared-definition>, last accessed 2018/05/27. (2013).
8. Breidbach, Ch.F, Brodie, R.J.: Engagement platforms in the sharing economy: conceptual foundations and research directions. *Journal of Service Theory and Practice*, Vol. 27, Is. 4, pp. 761-777. (2017).
9. Dolnicar, S.: Peer-to-Peer Accommodation Networks: Pushing the boundaries, Goodfellow Publishers Limited. (2018).
10. Dredge, D., Gyimöthy, S., Birkbak, A., Jensen, T.E., Madsen, A.K.: The impact of regulatory approaches targeting collaborative economy in the tourism accommodation sector: Barcelona, Berlin, Amsterdam and Paris. Impulse Paper No 9 prepared for the European Commission DG GROWTH. Aalborg University, Copenhagen. (2016).
11. Frost & Sullivan. Visionary innovation Mega Trends. <http://ww2.frost.com/research/visionary-innovation/>, last accessed 2018/05/26.
12. Geron, T.: Airbnb and the Unstoppable Rise of Share Economy, *Forbes*, 191: pp. 58-62. (2013).
13. Hamari, J., Sjöklint, M., Ukkonen, A.: The Sharing Economy: Why People Participate in Collaborative Consumption. *Journal of the Association For Information Science and Technology*, 67 (9), pp. 2047–2059. (2015).
14. Heinrichs, H.: Sharing economy: a potential new pathway to sustainability. *Gaia*, 224: pp. 228-231. (2013).
15. Heo, C.Y.: Sharing economy and prospects in tourism research. *Annals of Tourism Research*, 58C: pp. 166-170. (2016).
16. Hodson, M., Marvin, S.: *After Sustainable Cities?* Oxford, Routledge. (2014).
17. Hoonweg, D.: *Cities and Sustainability: A new approach.* Abingdon-Oxon, Routledge. (2016).
18. Lessig, L.: *Remix: Making Art and Commerce Thrive in the Hybrid Economy.* New York: The Penguin Press HC. (2018).
19. Martin, Ch., Upham, P., Budd, L.: Commercial orientation and grassroots social innovation: insight from the sharing economy. *Ecological Economics*, 118: pp. 240-251. (2015).

20. Martin, CH.J.: The sharing economy: A pathway to sustainability or a nightmarish form of neoliberal capitalism? *Ecological Economics*, 121: pp. 149-159. (2016).
21. Morozov, E.: The 'sharing economy' undermines workers' rights. <https://www.ft.com/content/92c3021c-34c2-11e3-8148-00144feab7de>, last accessed 2018/06/02. (2013).
22. Nawrocka, E, Jaremen, D.E.: Relations in the tourism supply chain. *Zeszyty Naukowe Uniwersytetu Przyrodniczo-Humanistycznego w Siedlcach*, 104: pp. 97-110. (2015).
23. Prothero, A., Dobscha, S., Freund, J., Kilbourne, W.E., Luchs, M.G., Ozanne, L.K., Thøgersen, J.: Sustainable consumption: Opportunities for consumer research and public policy. *Journal of Public Policy & Marketing*, 301: pp. 31-38. (2011).
24. PwC: The sharing economy – sizing the revenue opportunity. <http://www.pwc.co.uk/>, last accessed 2018/06/04. (2015).
25. Ranjbari, M., Morales-Alonso, G., Carrasco-Gallego, R.: Conceptualizing the Sharing Economy through Presenting a Comprehensive Framework. *Sustainability*, 10 (7): 2336-2360. (2018).
26. Richardson, L.: Performing the sharing economy. *Geoforum*, 67: pp. 121-129. (2015).
27. Sacks, D.: The sharing economy, <https://www.fastcompany.com/1747551/sharing-economy>, last accessed 2018/05/19. (2011).
28. Schor J. B., Fitzmaurice C.J.: Collaborating and Connecting: The emergence of the sharing economy. In: Reisch, L., Thøgersen, J. [eds]: *Handbook on Research on Sustainable Consumption* pp. 410-425. Cheltenham, Edward Elgar. (2015).
29. Skift Report. <https://skift.com/2015/03/25/airbnbs-revenues-will-cross-half-billion-mark-in-2015-analysts-estimate/>, last accessed 2018/05/10
30. Skift Report. <https://skift.com/2015/06/19/whats-an-airbnb-listing-worth-in-2015/>, last accessed 2018/05/10
31. Woskow, D.: Unlocking the sharing economy. An independent review. [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/378291/bis-14-1227-unlocking-the-sharing-economy-an-independent-review.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/378291/bis-14-1227-unlocking-the-sharing-economy-an-independent-review.pdf), last accessed 2018/05/04. (2014).
32. Wu, X., Zhi, Q.: Impact of Shared Economy on Urban Sustainability: from the Perspective of Social, Economic, and Environmental Sustainability. *Energy Procedia*, 104, pp. 191 – 196. (2016).
33. Young, W., Hwang, K., McDonald, S., Oates, C.J.: Sustainable consumption: Green consumer behaviour when purchasing products. *Sustainable Development*, 181: pp. 20-31. (2010).

## Sectors in the Czech Republic and International Tax Planning

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**Abstract.** Tax planning and its international dimension is effective way for reducing company's tax liability. Methods used within the tax planning have specific assumptions and not every company can achieve significant tax reduction. Tax planning schemes are strongly connected with intangible assets or capital structure. This contribution is focused on the different sectors and their position in the international tax planning. As a method, the cluster analysis has been selected to gain similar sets with similar sector's attributes. Database Albertina is used as a data source and there are selected variables which are related to the international tax planning. Results show that companies from the service sectors use more tax planning than companies from the others. Cluster analyzes report four sectors with higher application of the tax planning: Accommodation, Real Estate, Financial Sector and Electricity and Gas Supply. ICT is another sector which use tax planning more but the conclusions about it cannot be strong because one of the used clustering method does not include it beside above mentioned four sectors.

**Keywords:** Tax Planning, Sectors, Czech Companies.

### 1 Introduction

Tax avoidance belongs to one of the most important areas when it comes to modern management. Companies try to manage their tax liabilities to reduce them and therefore they apply tax planning activities. Successful tax planning has several assumptions and these activities are not suitable for all companies. Naturally, small businesses with few employees are not able to benefit from the extensive international tax planning. On the other hand, tax liability has a character of a cost for every business entity and every owner wants to have higher shares of profits. Therefore tax avoidance is an important part of the companies' activities and the international dimension shifts these activities further.

Companies from the Czech Republic also use tax avoidance and some of them have parent companies or subsidiaries located in the tax havens. International tax planning is one of the key activities which globalization brings and Czech companies as a part of the open economy have similar opportunities as companies from other countries.



From the perspective of the international tax planning, they can easily establish companies abroad and benefit from the better taxation conditions provided by tax havens' legislations. As in the case of size, the companies from certain sectors can have higher ability to use the tax planning and to gain greater tax savings.

After this introduction, the literature review is in the second chapter. Third chapter is dedicated to used methodology and data within the study. After presentation of the results the two last chapters, which are called the discussion and the conclusion, follow up.

## **2 Literature Review**

Current studies show importance of several factors connected with tax avoidance. First of all, there are frequently used techniques, which basically rest in profit shifting. Profit shifting can be connected with both assets and liabilities. Changes in the assets' or liabilities' structure can help companies to transfer profits into countries with lower tax burden.

As for assets, their structure is connected with relocation of them. Several studies mention mobility of intellectual property assets as an important attribute when it comes to tax planning [10, 18]. Intellectual property assets such as patents or licenses can be easily relocated into different countries and after that group can transfer profits using royalties. Karkinsky and Riedel also show that subsidiaries tend to apply less patents when their tax burden is higher [15]. Moreover, governments, which want to attract companies to move the company in their country, know about the mobility of intellectual property (IP) assets. This is the reason, why tax havens (but not only them) have special regimes of taxation for revenues from IP. This specific regime is often called as IP box and it is applied in several countries such as Ireland, Netherlands or the United Kingdom. Further studies show the importance of these special regimes with connection to the setting a location of patents or research activities [2, 4]. Tax burden becomes the one of the key factor when managers of companies decide about location of their investment, especially in the situation, when the investment have more intangible character.

Loans between two parts of group are relatively often mentioned tax planning scheme [3, 5]. Therefore variables carrying information about them are widely included in analyzes dealing with the tax planning.

Czech companies are part of the data in some of the mentioned studies. On the other hand, the results of them are significantly influenced by more numerous sets of companies from larger countries [13]. Therefore, there are studies which aim only situation connected with Czech companies. First of all, Czech companies use extensively tax havens [17]. Study from Jánský and Kokeš is focused on the Czech companies and data from 2010; results show that the ownership relationship with tax haven have positive effect on the debt ratio of Czech company [12]. This can be an indicator of using intragroup loans and with them associated interest payments as way of tax planning. On the other hand, mentioned study does not provide any significant result about effect of these activity to the tax liabilities. From the perspective of the

situation in the Czech Republic, it is also needed to mention the groups' preferences of the headquarters [9]. Whereas there are a lot of subsidiaries of foreign groups in the Czech Republic, profit shifting is more common than in other EU countries.

From the perspective of the sectors, current studies indicate several interesting facts. One of the most important thoughts follows up on the knowledge about the structure of assets. Tax planning is mostly connected with the companies from high-tech sectors with higher importance of the patents and other types of intangible assets [14]. Sector as a determinant of the tax planning is used within several studies [8, 19]. Also the situation of the tax planning in the sector is important for the companies' behavior. Companies from the sectors, where companies use extensively tax planning, are not sensitive on the taxation when it comes to new investment [19].

Some evidence of international tax planning is relevant for the financial sector. Studies [1, 16] show how much banks avoid paying taxes and which countries they use for profit shifting. From the type of sector in general, companies offering services should have better opportunities to use international tax planning than the companies from the sectors, which are strongly connected with tangible assets [12]. On the other hand, when it comes to new investment, manufacturing companies in Germany are more sensitive to the taxation conditions than companies from service sectors [11].

This contribution is focused on the situation of the sectors and their relation to the tax planning in the Czech Republic. More specifically, this paper aims the situation of Czech companies owned by foreign parent companies based in other EU countries. Based on the current state of knowledge, there are some determinants of the tax planning which are considered in further analysis. These tax planning schemes are strongly connected with specific group of assets and liabilities' structure, therefore closer look on the sectors can bring new information about the tax planning in the certain sector. The goal of this paper is to divide sectors into groups from the perspective of the tax planning.

### **3 Methodology and Data**

Groups of sectors with similar characteristic are identified using cluster analysis. Cluster analysis uses distance between objects related to selected variables and based on these distances are calculated objects with similar position. In this analysis, objects are sectors defined based on CZ-NACE [6, 7]. There are some sectors, which were for this analysis divided into several groups because of the broad scope. Mentioned division counts mainly for the manufacturing. The sectors for this analysis are defined as follows: Agriculture; Production of Electricity, Gas etc.; Water Industry; Construction; Transport; ICT; Accommodation; Real Estate; Financial Sector; Professional; Administration; Mining; Culture; Education; Wholesale; Retail; Car Trade; High-Tech Manufacturing; Low-Tech Manufacturing; Healthcare and Other. Presented sectors are the cases within the cluster analysis.

Variables, on which the clustering is made are presented in the following Table 1. Selected variables were used because of the extensive evidence of their importance

for companies' effective tax rates. All data used within the cluster analysis is drawn from the Albertina, database with data from the Czech companies.

**Table 1.** Variables used within Cluster Analysis.

Name	Description
Tax Haven	Share of the foreign owned Czech companies with the parent in the tax haven
Taxes	Average of the taxes value divided by sum of revenues
Assets	Median of the natural logarithm of the asset value
ROA	Median of the Return on Assets
Debt Ratio	Median of the debt ratio
Intangible Assets	Average of the share of intangible assets on the fixed assets
Zero Taxes	Share of the companies with zero tax

Whereas the study uses group of the tax havens, it is needed to define the set of them. The study is focusing on EU parent companies of the Czech ones, so the tax havens within this study are EU member countries, which are frequently considered as tax havens. There are five EU countries, which are mostly included in the set of tax havens: Cyprus, Ireland, Luxembourg, Malta and Netherlands [3, 5].

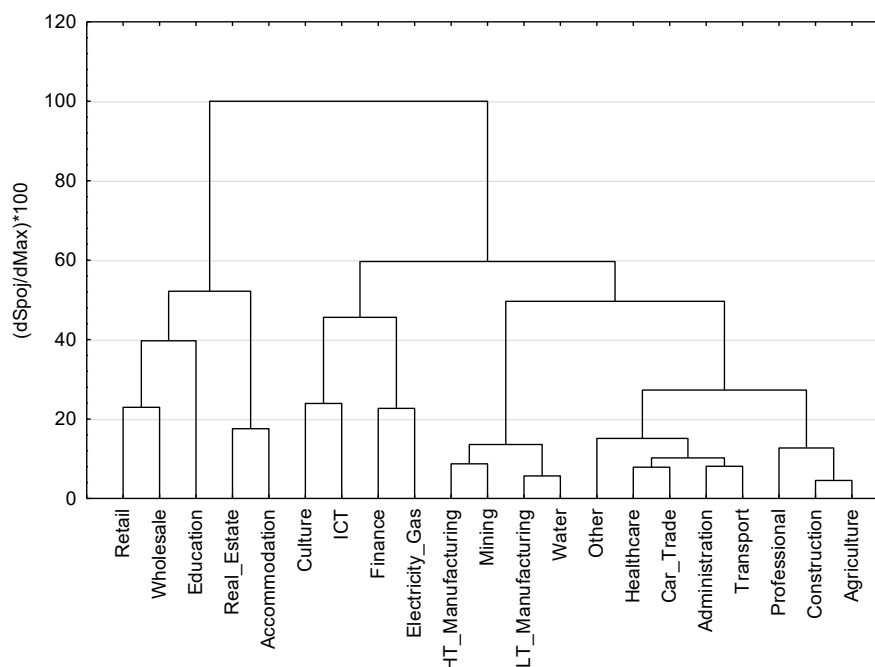
There are many types of cluster analysis, respectively methods of calculations used within them. We use the Euclidean distance and two types of cluster analysis: Ward's method and K-means method.

## 4 Results

Results are presented by dendrogram or a table. This difference of presentation is caused by different types of methods. Dendrogram is suitable only for the Ward's method from the two which were selected.

### 4.1 The First Run – All Sectors

Figure 1 presents results of for Ward's method with Euclidean distance. The graph shows that there are five clusters at the half of distance, so there are relatively many of them considering the number of monitored sectors. First dendrogram shows that somehow related sectors are included in the same cluster, e.g. High-Tech and Low-Tech Manufacturing or services like Culture, ICT or Financial sector.



**Fig. 1.** Ward's Method of Cluster Analysis – the first run.

First run of the cluster analysis already reports some more important results. First of all, two of the clusters consist only from two sectors (the run with using K-means method – Table 2). Electricity and Gas and Financial sector form together one of the small clusters. These two sectors have high level of companies owned from the tax haven and the companies within these sectors belong to the biggest. Second two-member cluster includes Real Estate and Accommodation. For these two sectors are typical also relatively high level of companies owned from the tax haven and high level of companies with zero tax. Another important fact about this cluster is the value of assets because companies from these two sectors are smaller in comparison with the others' value of assets.

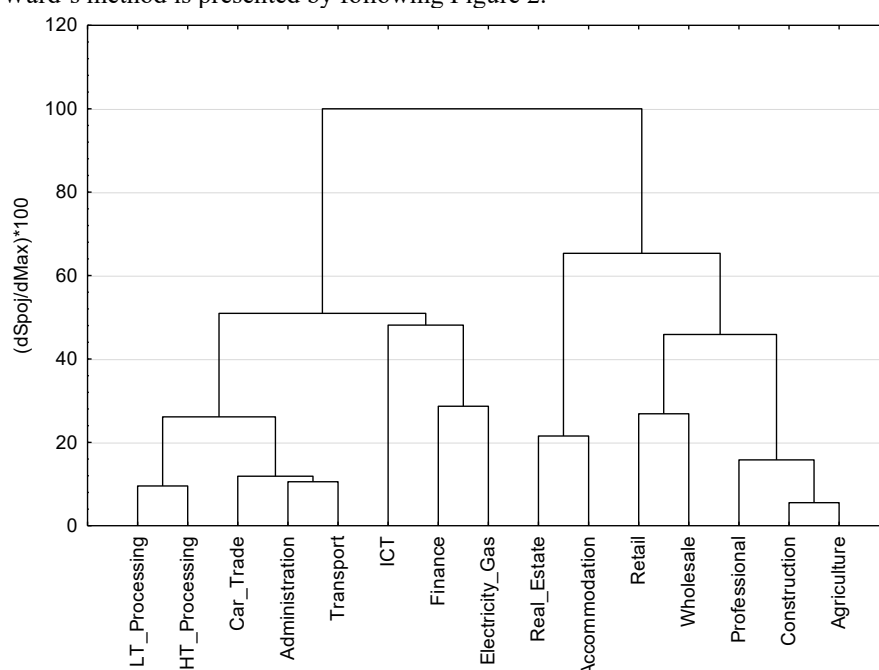
**Table 2.** K-means Cluster Analysis – the first run.

Name	Members
Cluster A1	Agriculture, Construction, Professional, Culture, Education, Wholesale, Retail
Cluster B1	Transport, ICT, Administration, Car Trade, Healthcare, Other
Cluster C1	Mining, High-Tech Manufacturing, Low-Tech Manufacturing, Water
Cluster D1	Accommodation, Real Estate
Cluster E1	Electricity and Gas, Finance

Some of the sectors have only a few members because of their characteristics. Therefore we continue with second run of the cluster analysis with reduced data.

#### 4.2 The Second Run – Reduction of the Data

For better understanding of manager behavior, it is important to abstracted from the objects with small amount of members and reduce the number of sectors where every single one have at least 92 companies owned from foreign country which corresponds with at least one percent share of the monitored companies. From mentioned reasons, five sectors and section “Other” were excluded from the second run. Results of the Ward’s method is presented by following Figure 2.



**Fig. 2.** Ward’s Method of Cluster Analysis – the second run.

Following Table 3 show the result of the K-means method. Based on the results from the second run, there are two groups of sectors in which companies use tax planning in broader scope. First cluster is formed by Accommodation and Real Estate. At the first sight, these two are relatively close sectors of services and their position in the international tax planning seems to be very similar. Both of them have high share of companies with owner in the tax haven, companies has high debt ratio and they are relatively small in terms of asset value. The second two-member cluster consists from the Financial sector and Electricity and Gas. Companies in these two sectors also use tax havens but there are larger considering the asset value. This is caused by different character of the sectors from these two clusters. Other values for the variables are not

as biased as ones connected with Real Estate and Accommodation. Even though we identify that companies from the Cluster D2 use tax planning more often than sectors in the clusters A2 or B2.

**Table 3.** K-means Cluster Analysis – the second run. Source: Authors.

Name	Members
Cluster A2	Agriculture, Construction, Professional, Wholesale, Retail
Cluster B2	Transport, ICT, Administration, Car Trade, High-Tech Manufacturing, Low-Tech Manufacturing
Cluster C2	Accommodation, Real Estate
Cluster D2	Electricity and Gas, Finance

Overall, there are some sectors, in which companies are more interested in tax planning activities. From the perspective of the Czech Republic, service sectors are the ones with higher level of the international tax planning. This may be caused also by the economic situation of the each sector.

## 5 Discussion

Results of this study show significant differences between sectors in terms of using the tax havens. Czech companies from the services' sectors use tax avoidance in greater extent. There is no quantitative variable connected with groups of the sectors which use tax planning. The most important thing seems to be a character of the sector. Service companies are closer to new technologies and they are influenced by globalization more than companies e.g. from the Agriculture or Construction. The differences between service and other companies is also discussed in other studies [11, 12]. Interesting result connected with German companies shows that German service companies have better opportunity to establish company in the tax haven which has real economic activity in the country [11]. This is an important fact which should be discussed also in relation with the Czech Republic: it would be beneficial to find if tax havens' parents have their own real economic activity in the particular country.

Clusters with the companies which used tax havens have slightly higher debt ratio than the others. This result is consistent with the studies showing importance of intra-group loans [3, 5] and with the results connected with Czech companies [12]. On the other hand, there are not much difference in the share of intangible assets. It might be caused by tax planning schemes because companies using tax planning, relocated these types of assets and have the reduced share e.g. of patents than it is usual in the industry.

It has to be take into account that only the companies, which are owned from the foreign country, are studied in this contribution. This link is defined as direct so there are also companies which are not directly owned from the tax havens but have an indirect link to them. Therefore the international tax planning are applied more than the data show at the first sight. On the other hand, the clustering assesses the degree of similarity of studying objects therefore we can show the sectors' differences even with analysis of this type of data. It is important to emphasize this fact because it brings new

opportunities for further studying. When the international tax planning would be analyzed deeper, there can be different ways of it in each sector. Companies from the first one can use the direct link, ones from another indirect. It depends on every sector and every country, in which the company operates. Therefore further studies should consider deeper analysis of the tax avoidance practices in each sector individually.

## 6 Conclusion

This study shows the importance of taxes and international tax planning in decisions of managers. When the company has an opportunity and can gain a tax advantage, managers tend to use tax avoidance. From the perspective of the Czech companies, especially the service sectors tend to use the tax havens.

The difference between sectors should be considered in every study related to the tax planning, at least at the level of different structure of assets and capital. On the other hand, this study shows that there are other important differences between sectors based on their character. Therefore information about sector is needed for better results of the tax planning analyzes. Further studies should go deeper to identify how sector of the company influences tax planning schemes.

## References

1. Aubry, M., Dauphin, T.: Opening the vaults: the use of tax havens by Europe's biggest banks (2017). DOI: 10.21201/2017.9361.
2. Barrios, S., Alstadsæter, A., Nicodème, G., Skonieczna, A. M., Vezzani, A.: Patent boxes design, patents location and local R&D. Office for Official Publications of the European Communities, Luxembourg (2015).
3. Berkhout, E.: Tax Battles: The dangerous global race to the bottom on corporate tax. Oxfam international. Oxfam GB, Oxford (2016). <https://www.oxfam.org/en/research/tax-battles-dangerous-global-race-bottom-corporate-tax>.
4. Bieltvedt Skeie, Ø., Menon, C., Johansson, Å., Sorbe, S.: Innovation, patent location and tax planning by multinationals. OECD Economics Department Working Papers (2017). DOI: 10.1787/b08459e5-en.
5. Chardonnet, A., Langerock, J.: Blacklist or whitewash? What a real EU blacklist of tax havens should look like. Oxfam international. Oxfam GB, Oxford (2017). <https://www.oxfam.org/en/research/blacklist-or-whitewash-what-real-eu-blacklist-tax-havens-should-look>.
6. Český statistický úřad: Klasifikace ekonomických činností (CZ-NACE), [https://www.czso.cz/csu/czso/klasifikace\\_ekonomickych\\_cinnosti\\_cz\\_nace](https://www.czso.cz/csu/czso/klasifikace_ekonomickych_cinnosti_cz_nace), last accessed 2018/11/16.
7. Český statistický úřad: Rozdělení zpracovatelského průmyslu podle technologické náročnosti, [https://www.czso.cz/documents/10180/23169600/ht\\_odvetvi.pdf/cb4dc782-a3e0-43a4-8d96-99b8d1f14cca](https://www.czso.cz/documents/10180/23169600/ht_odvetvi.pdf/cb4dc782-a3e0-43a4-8d96-99b8d1f14cca), last accessed 2018/11/16.
8. Delgado, F. J., Fernandez-Rodriguez, E., Martinez-Arias, A.: Effective Tax Rates in Corporate Taxation: a Quantile Regression for the EU. *Engineering Economics*, 25(5), 487-496(2014). DOI: 10.5755/j01.ee.25.5.4531.

9. Dischinger, M., Knoll, B., Riedel, N.: The role of headquarters in multinational profit shifting strategies. *International Tax and Public Finance* 21(2), 248-271(2014). DOI: 10.1007/s10797-012-9265-5.
10. Griffith, R., Miller, H., O'Connell, M.: Ownership of intellectual property and corporate taxation. *Journal of Public Economics*, 112, 12–23(2014). DOI: 10.1016/j.jpubeco.2014.01.009.
11. Gumpert, A., Hines Jr, J. R., Schnitzer, M.: Multinational firms and tax havens. *Review of Economics and Statistics*, 98(4), 713-727(2016). DOI: 10.1162/rest\_a\_00591.
12. Janský, P., Kokeš, O.: Corporate tax base erosion and profit shifting out of the Czech Republic. *Post-Communist Economics*, 27(4), 537–546 (2015). DOI: 10.1080/14631377.2015.1084733.
13. Jedlička, V.: International Tax Planning: Current State of Knowledge. *European Financial and Accounting Journal*, 2017(4), 31-46(2017). DOI: 10.18267/j.efaj.199.
14. Jones, C., Temouri, Y.: The determinants of tax haven FDI. *Journal of World Business*, 51(2), 237-250(2016). DOI: 10.1016/j.jwb.2015.09.001.
15. Karkinsky, T., Riedel, N.: Corporate taxation and the choice of patent location within multinational firms. *CESifo Working Paper*, No. 2879 (2009). [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1532668](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1532668).
16. Murphy, R.: *European Banks' Country-by-Country Reporting* (2015). <http://www.taxresearch.org.uk/Documents/CRDivCBCR2015.pdf>.
17. Novotný, J., Kruml, L.: Development of Tax Havens due to Globalization Processes and their Impact on the Czech Republic. In: *Proceedings of the 15th International Scientific Conference on Globalization and its Socio-Economic Consequences*, pp. 531-537. University of Zilina, Rajecké Teplice (2015).
18. OECD: *Harmful Tax Competition – An Emerging Global Issue*. OECD Publications. Paris (1998). [http://www.keepeek.com/Digital-Asset-Management/oecd/taxation/harmful-tax-competition\\_9789264162945-en#.WVdmmIjyIU#page15](http://www.keepeek.com/Digital-Asset-Management/oecd/taxation/harmful-tax-competition_9789264162945-en#.WVdmmIjyIU#page15). DOI: 10.1787/9789264162945-en.
19. Sorbe, S., Johansson, Å.: *International tax planning and fixed investment*. OECD Economics Department Working Papers, No. 1361 (2017). DOI: 10.1787/83239540-en.



## The Effect of a Face on Packaging from the Perspective of Marketing Communication with Older Consumers

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**Abstract.** The article aims at researching the response of older consumers to a face image on the packaging of food products, with an emphasis on the number of faces, their age and the viewing direction. The study is based on the findings of eye-tracking research and surveys conducted on elderly respondents. Two packages of flour were used for the research, each of which appeared in five variants: four with face images (an older and a younger woman, an old woman with a granddaughter and the whole family), as well as a control package without an image of a person. Moreover, the older consumers' visual attention and the intentionality of a purchase were analysed. It was established that products with faces on their packaging attract the older respondents' visual attention and shorten the identification time but are consciously ignored in declarative shopping. Therefore, a higher visual attention drawn to packaging with images of faces does not entail a higher purchasing preference among senior buyers. What is more, it turned out that ecological symbols and those indicating the rural nature of a product, such as the sun or ears of grain, are more valuable for the prediction of the buying decision of older consumers. The article is research-based and conceptual.

**Keywords:** Buying Behaviour, Older Consumer, Communication, Packaging, Face, Food.

### 1 Introduction

Through the increasing number of visual stimuli, modern marketing forces consumers to be constantly visually active. This leads to a situation in which consumers' decisions are based almost entirely on visual stimuli. People are protected against the overflow of visual information by the brain, which analyses the incoming stimuli and decides whether they should be absorbed in an automatic manner (*System I*), or consciously (*System II*) [8]. Numerous researchers hold an opinion that this process is determined by the emotional significance of a stimuli for the consumer [1]. For the majority of people, the most common emotional stimuli are faces, which have the highest ability of attracting attention, which may lead to a purchasing decision [12]. In comparison to other visual stimuli, faces are more quickly noticed, and their emotional input may affect the recipients' attitudes and purchasing motivations. Smiling faces, at an appropriate age, looking directly at the consumer, a single person or a group of people,

determine the consumers' attitudes and buying intentions. However, consumers' reactions to images of people may vary. Research results show a different response to faces in marketing messages of younger and older consumers [4, 6]. Due to the prospectivity of the market segment of senior consumers in Poland [11], this research has been limited to this group of buyers. The interest in older consumers also resulted from the lack of research into the issue of the influence of age on the preferences for products with face images. The authors limited their study to the packaging of food products, as this category of products is most frequently bought by older consumers. The first part of the article presents the major theoretical and empirical background of the effect of a face on packaging on older consumers. The further part includes the research methodology and the findings.

## **2 The Research Methodology and Findings**

The experiment was conducted in the Consumer Research Laboratory of Poznań University of Economics and Business and consisted of an eye-tracking part and a survey. 32 female respondents took part in the experiment. However, after eliminating the questionnaires with deficient data or faulty eye-tracking measures, the sample of 25 respondents remained. Owing to the small size of the sample and the way in which the respondents were selected, this research should be regarded as a starting point for further studies, rather than a comprehensive reply to the research questions. As the research was related to packets of flour, only women were invited to take part. The youngest respondent was 51 and the oldest - 77. The average age of the respondents was 61. 17 respondents declared a very good health condition, 10 of them stated that their health is good, 4 women claimed to have a medium state of health and one of them declared to have poor health. The respondents were professionally active – 24 of them working full-time and two - occasionally. None of them declared to be unemployed or a pensioner. Therefore, the majority of the respondents represent a relatively high-income level, which might contribute to their self-fulfilment and life satisfaction higher than the average level for this age group.

The first part of the experiment consisted in studying the parameters of respondents' visual attention. Their pupil movements, the fixation and the viewing direction were measured by means of a mobile eyetracker. It identifies the spot a person is currently looking at and enables tracking the route covered by the respondent's sight. In the first part of the study 2 packets of flour were used (in two colors: green and yellow). Each packet appeared in 5 research variants:

- a young woman's face (ca. 20 – 25),
- an older woman's face ('I'm just like you'),
- a grandmother's and a granddaughter's faces (family),
- family faces (parents and children, model 2+1 or 2+2),
- no faces.

For one of the packets, the condition of the viewing direction was applied (faces with direct and indirect viewing). The faces used in the research were smiling, with moderate emotionality, characteristic of European culture.

In the second part of the research a survey was conducted, aiming at defining the cognitive age of the respondents and the intentional purchase of the products. The respondents were asked to select a packet of flour which most encouraged a purchase. Next, by means of the 5-degree Likert scale (1 – absolutely not and 5 – definitely yes), they assessed the product's quality, the aesthetic value of the packaging and its colors. They also referred to statements such as: "This product guarantees a successful cake", "This product inspires trust", "The packaging encourages buying".

The research findings analysis began with the AIO eye-tracking data, primarily based on the comparison of three values for the specific areas of the packaging (table 1):

- average total dwell time,
- average number of revisits,
- average fixation time.

**Table 1.** Comparison of the AIO eye-tracking indicators for the analyzed variants of packaging.

Packaging colour	Packaging variant	Packaging element	Total dwell time	Number of revisits	Average fixation duration
Green	Young person	Face	1081.7	2.2	210.8
		Logo	686.3	1.3	223.7
		Information	1733.7	2.5	239.1
	Older person	Face	954.7	2.3	221.2
		Logo	923.8	1.7	242.9
		Information	2022.4	3.7	223.4
	Grandmother with granddaughter	Faces	1552.2	2.3	243.7
		Logo	591.9	1.1	204.8
		Information	1105.7	1.7	189.7
	Family	Faces	1882.5	2	252.4
		Logo	518.2	1.3	172.7
		Information	1122.2	2.5	170.6
Yellow	Young person	Face	1093.9	1.9	221.3
		Logo	934	1.6	166.1
		Information	2134.8	3	178.2
	Older person	Face	1165.4	2.2	245.9
		Logo	878.2	1.3	191.8
		Information	2977.8	3.5	234.4
		Faces	1087.4	1.8	190.5

Grandmother with granddaughter	Logo	1137.4	1.4	187.5
	Information	1890.4	2.6	221
Family	Faces	1356.8	2.7	172.5
	Logo	816.6	1.6	136.3
	Information	2079.4	2.7	192.7

\* Revisits refer to the return of a respondent's attention to a specific element of a packet

\* Fixation is defined as the time of focusing visual attention on a specific element.

The analysis of these eye-tracking data allows for the verification of the H1 hypothesis. Of all the three specified graphic elements of the packaging: face(s), logo and the basic information: "wheat flour type 500", the most attention drawing is the information about the type of the product. This information received the longest total dwell time, the highest number of revisits and the longest time of a single viewing. Regardless of the packaging colour, as well as the research variant (family, grandmother with a granddaughter, a younger or older face), respondents paid the highest amount of visual attention to the verbal information about the product. This result is hardly surprising, as the identification of verbal information is a more time-consuming process than absorbing a non-verbal image. However, it should be noted that the indicators of the eye-tracking study for faces have higher values than those for logotypes. Not only the total dwell time, but also the number of revisits and the time of a single fixation have higher values. For the green packaging in the variant: grandmother with granddaughter the total dwell time is nearly three times longer (1552 vs. 591 ms). Likewise, the number of revisits is twice as big (2.3 vs. 1.1). All in all, it is worth emphasizing that although a face is not the most significant element on packaging, it does not remain unnoticed. Despite the fact that the H1 hypothesis must be refuted (the basic verbal information drew more visual attention than the faces), the images of people attracted more visual attention of the consumers than the producer's logo.

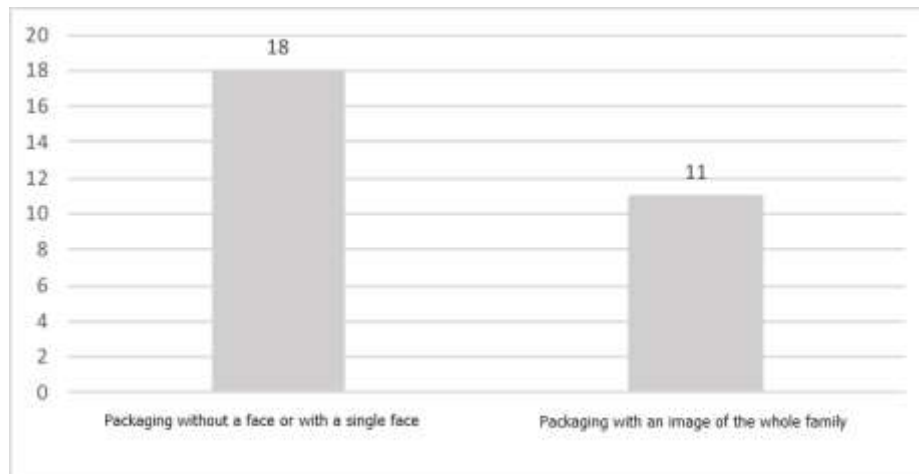
With a view to verifying the H2 hypothesis, the eye-tracking research results for two packaging variants: with direct and indirect viewing were compared (table 2).

**Table 2.** Perception of packaging in terms of the viewing direction of the face.

Viewing direction	Total dwell time	Number of revisits	Number of fixations	Fixation time
Direct	2071.71	2.53	7.28	266.73
Indirect	1362.82	1.84	4.50	229.25

The H2 hypothesis has been corroborated. The packaging of a product with face viewing directly attracted more visual attention from the respondents. The values of the analysed eye-tracking indicators were higher for this research variant.

The analysis of the survey allows for verifying the H3 hypothesis through the comparison of the declarative choice of a packet (Figure 1).



**Fig. 1.** Preferences for packets in relation to the number of faces

A packet without a face was most frequently selected (by 17 respondents, which accounts for 60%). 7 persons would buy a packet with the image of a grandmother and a granddaughter, whereas only two respondents chose the one with a few family members. Nobody declared the purchase of a product with the image of a young woman and only one respondent selected the packet with the image of an older woman. Consumers display a lower tendency to purchase products with the faces of a whole family than those promoted by one person or without any images of people. Therefore, the H3 hypothesis has been corroborated.

Both the eye-tracking research findings presented in table 1 and the results of the survey allow for a positive verification of the H4 hypothesis. Among the specified research variants, the elderly consumers displayed higher values of the eye-tracking indexes for packets with the image of an older person than that of a young one. It should be pointed out, however, that in spite of the intensified visual attention devoted to the face of an older person, they are not willing to buy a product with this image. Older consumers prefer packets without any images of persons. As it was mentioned earlier, nearly 60% of the whole group of respondents chose a packet without a face.

### **3 The Effect of a Face on Packaging in Communication with Mature Consumers**

Images of persons are a significant part of marketing messages. Photographs of whole figures or only the faces of male and female models appear in all forms of advertising. They are present in advertisements, promotional materials, billboards, also on packaging and in e-commerce in the broad sense of the term. The faces of persons on packaging play a significant role in shaping the behaviours and the attitudes of consumers in relation to brands and products. A human face, as an element well-known to the recipient, makes the product more accessible and less “alien” [18]. However, a

face should display certain qualities, in order to attract the attention of a target consumer. Research findings [2] confirmed differences in consumers' responses to a face image in relation to the physical attractiveness of the presented person. The attractiveness of the person shown in a marketing message draws attention and arouses interest, but sometimes also causes some discomfort resulting from the recipient's low assessment of their own appearance. Therefore, the authors formulated the following hypothesis:

*H1: Of all the elements of packaging, a face attracts the highest visual attention of elderly consumers.*

What is more, a consumer's interest in a product depends on the viewing direction of the model. From the point of view of the effectiveness of marketing communication, it is essential to properly design the viewing direction – direct or indirect. Direct viewing means that the model's eyes are looking straight forward (in the consumer's direction); whereas averted viewing means that the model's eyes are looking to the side, or simply not in the consumer's direction. Most frequently the model is looking at a brand or a product, much less often in an unspecified direction. Research findings into this issue are ambiguous. The research conducted by Wang, Wedel, Huang and Liu [17] on over 200 websites indicated that direct and indirect viewing occur equally frequently. Others claim that direct viewing results in a higher concentration on the middle part of the model's face, delaying the identification of peripheral objects [14]. On the other hand, the averted viewing may shift the consumer's sight and attention, leading to a quicker identification of objects located outside the model's face. Sajjacholapunt and Ball [13] proved that placing a face looking in the direction of a brand or a product raises the interest in the product and facilitates remembering information which allows for formulating the following hypothesis:

*H2: With respect to older consumers, packaging with directly viewing faces attract more visual attention than those with indirectly viewing faces.*

Belonging to the older-age segment is defined in terms of three categories – the nominal, biological and cognitive age [7]. The nominal age is related to the date of birth, which allows for a further division of seniors. Notes on packaging: 40+, 50+, or 60+, which are sometimes referred to as stigmatising a consumer, are used on many cosmetic products dedicated to older persons. Nevertheless, there is no certainty that this is an effective marketing impulse in communication with older consumers. The biological age defines the condition of the organism, resulting from the earlier life style, illnesses and injuries. The concept of the cognitive age refers to the thoughts and feelings of an individual person in relation to the subjective perception of their own age and condition. The cognitive evaluation of age is individually formed and changes as a result of a disease, retirement, or losing a partner. It is the cognitive age that determines life satisfaction and its discrepancy with the chronological age are strongly related to self-esteem [15]. Mathus et al. [9] claim that the use of cognitive age in the context of senior consumers allows for a better understanding of the way in which age affects their purchasing behaviour.

Life satisfaction is an ambiguous term which refers not only to happiness or well-being, but also to the quality of life. Life satisfaction is defined as the overall assessment of one's own achievements and life conditions, which changes in time [3]. Life

satisfaction usually refers to the specific spheres of life – family life, professional activity, health and financial situation. Professional inactivity, deterioration of health, reduction of income and the loss of social relations experienced at an older age make it necessary to satisfy one's needs according to a specific hierarchy. Therefore, it can be concluded that older consumers feel diminished life satisfaction [19]. A significant aspect of life quality, determining life satisfaction, are family relations and satisfaction with family and children. It appears, though, that with the growing age this type of satisfaction is decreasing. The age group most satisfied with their children are young parents (aged 25 – 44). Among people aged 55 and more diminished satisfaction with children is observed [20]. Older parents are not as satisfied with their children as the younger ones, which makes the image of a family (seniors with children and grandchildren), as well as young faces on packaging less attractive to them. This leads us to the formulation of the following hypothesis:

*H3: The declining life satisfaction of elderly consumers leads to a decrease in the attractiveness of a family image, which, in turn, results in their lower preference for products with images of the whole family on the packaging.*

On the basis of research, Berg, Söderlund i Lindström [1] assumed that faces expressing positive emotions build consumers' positive attitudes towards the products, by way of the process of infecting with emotions (imitation). Moreover, there is empirical evidence [4] that older people pay more attention to and remember better positive faces than negative ones. It can be assumed that the common presence of the smiling faces in marketing messages will emphasise the reality of the respondents' situation and at the same time will allow for verifying the viewing direction and the model's age, as well as the number of faces displayed on packages in the process of an intentional purchase. The face's age affects the consumer's cognitive effort. Older persons' faces usually require more time for identification than younger ones, due to their complexion and wrinkles. That is why it is assumed that it is easier to control the expression of younger faces. Older persons appreciate the attractiveness of young faces; however, feeling the deficit of this quality in themselves, will rather purchase products promoted by their peers. As a result, the following hypothesis was formulated:

*H4: For senior consumers packaging with an image of an older face draws their visual attention but is not the subject of an intentional purchase.*

\*The full family is understood as a grandmother with a granddaughter and a few other family members.

## 4 Conclusions

Results of the research show that presumably the face effect on a product packaging does not play as significant role in reference to older consumers as it was expected. Only a few of the respondents noticed faces. What is more, they preferred packets without a face image or with only one face. A question remains whether the lack of the strong effect of a face would be present on a larger scale and in the more realistic conditions of shopping, or with reference to another category of products.

The article contributes to determining the direction of the impact made on the older consumers' preferences by such packaging elements like faces of people promoting a product. The main limitation of our study is a relatively low number of participants. A bigger sample could have resulted in more reliable results. The research was conducted on a very small group of respondents, all of whom being professionally active. Moreover, their tasks were related to the assessment of one product displayed on a screen. Creating more realistic conditions – more options to choose from, or a time limitation, could induce the respondents to use System I in their decision-making process, which would entail quicker and more automatic choices, with the exclusion of the conscious processing of information. Additionally, the respondents' professional activity and their life satisfaction, probably accompanied by emotional stability, could contribute to their omission of faces in the assessment of the presented packages and affect their purchase decisions.

Another factor which may have played a role in this research was the fatigue effect – each respondent evaluated 10 packages, which could result in tiredness and lower concentration. Another limitation of the research was the fact that only persons with good eyesight were admitted (persons with a sight defect stronger than  $\pm 2$  dioptries, wearing contact lenses, with glaucoma, a cataract or with an eyeball implant were excluded), which may have limited the adequacy of the obtained results in relation to the group of older consumers.

## References

1. Berg, H., Söderlund, M., Lindström, A.: Spreading joy: examining the effects of smiling models on consumer joy and attitudes. *Journal of Consumer Marketing*, 32(6), 459-469 (2015). DOI:10.1108/JCM-03-2015-1356.
2. Bower, A. B., Landreth, S.: Is Beauty Best? Highly Versus Normally Attractive Models in Advertising. *Journal of Advertising*, 30(1), 1-12 (2001).
3. Diener, E., Emmons, R. A., Larsen, R. J., Griffin, S.: The Satisfaction with Life Scale. *Journal of Personality Assessment*, 49(1), 71 (1985).
4. Ebner, N. C., He, Y., Johnson, M. K.: Age and emotion affect how we look at a face: Visual scan patterns differ for own-age versus other-age emotional faces. *Cognition & Emotion*, 25(6), 983-997 (2011). DOI: 10.1080/02699931.2010.540817
5. Ekman, P., Friesen, W.V.: Constants across cultures in the face and emotion, *Journal of Personality and Social Psychology*, 17 (2), 124–129 (1971).
6. Jerzyk, E.: Możliwości i ograniczenia wykorzystania eye-trackingu w badaniach starszych konsumentów, *Marketing i Zarządzanie*, 2, s. 133-140 (2017).
7. Jerzyk, E.: Wymagania starszych konsumentów wobec opakowań jednostkowych, *Marketing i Rynek*, 6, s. 318-329 CD (2014).
8. Kahneman, D.: Pułapki myślenia. O myśleniu szybkim i wolnym. Poznań: Media Rodzina (2012).
9. Mathur, A., Ong, F., Fatt, C., Rakrachakarn, P., Moschis, G.: Beyond cognitive age: developing a multitheoretical measure of age and its assessment. *Journal of Marketing Analytics*, 5(1), 31-43 (2017) DOI:10.1057/s41270-017-0011-9
10. Mccracken, G.: Who Is the Celebrity Endorser? Cultural Foundations of the Endorsement Process. *Journal of Consumer Research*, 16(3), 310-321 (1989).



11. Olejniczak, T.: Przemiany segmentu konsumentów seniorów w Polsce, „Marketing i rynek”, luty, s. 196-210, [http://www.marketingirynek.pl/files/1276809751/file/ibrkk\\_cd\\_mir2\\_2005.pdf](http://www.marketingirynek.pl/files/1276809751/file/ibrkk_cd_mir2_2005.pdf) (2015)
12. Pieters, R., Warlop, L.: Visual attention during brand choice: The impact of time pressure and task motivation. *International Journal of Research In Marketing*, 16(1), 1-16 (1999).
13. Sajjacholapunt, P., Ball, L. J.: The influence of banner advertisements on attention and memory: human faces with averted gaze can enhance advertising effectiveness. *Frontiers in Psychology*, 5, 166. <http://doi.org/10.3389/fpsyg.2014.00166>, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3941030/>, last accessed: 21.03.2018.
14. Senju, A., Hasegawa, T.: Direct gaze captures visuospatial attention, *VISUAL COGNITION*, 12 (1), 127-144, <https://pdfs.semanticscholar.org/790e/6f93164f92eb7fdc7585e1dfd912a60a0b02.pdf>, last accessed: 21.03.2018.
15. Sirgy, M. J.: Self-Concept in Consumer Behavior: A Critical Review. *Journal of Consumer Research*, 9(3), 287-300 (1982).
16. Wang, Q., Wedel, M., Huang, L. Liu, X.: Effects of model eye gaze direction on consumer visual processing: Evidence from China and America. *Information & Management* (2017), <https://doi.org/10.1016/j.im.2017.12.003> (2016).
17. Wang, Q., Yang, Y., Wang, Q., Ma, Q.: The effect of human image in B2C website design: an eye-tracking study. “Enterprise Information Systems”, No. 8(5) (2014).
18. Wiśniewska, M., A., Liczmańska, K.: Wykorzystanie postaci jako instrumentu perswazji w reklamie, *Roczniki Ekonomiczne Kujawsko – Pomorskiej Szkoły Wyższej w Bydgoszczy*, nr 4, 133-149 (2011).
19. Włodarczyk-Śpiewak, K.: Aspekty jakości życia a poziom satysfakcji życiowej Polaków, Nierówności społeczne a wzrost gospodarczy, nr 9, *Problemy globalizacji i regionalizacji*, cz.2, 513-526 (2006).
20. Zadowolenie z życia, Komunikat z badań, CBOS, nr 3/2017, [http://www.cbos.pl/SPISKOM.POL/2017/K\\_003\\_17.PDF](http://www.cbos.pl/SPISKOM.POL/2017/K_003_17.PDF) (2017).

## Modified Positional TOPSIS Method for Assessing the Socio-Economic Development Level of Rural Municipalities

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**Abstract.** Rural municipalities face many problems affecting their socio-economic development. These issues can be effectively addressed only if these units are assessed on a comprehensive basis. The socio-economic development is a complex phenomenon and its assessment requires taking into account many determinants. These features are often characterized by strong asymmetry or extreme observations. For the researchers, this is a considerable complication which cannot be dealt with using classic diagnostic methods because even a single outlier for a given object may significantly affect the analysis and the resulting conclusions. In view of the above, the relevant research should place a stronger focus on outlier-robust methods. Therefore, the objective of this paper was to use a modified positional TOPSIS method to assess the socio-economic development level of Polish rural municipalities in 2017. This approach reduces the adverse impacts of extreme skewness and outliers of features on the assessment of municipal development levels through the use of the spatial median of Weber and the extreme values identification method used in the Peaks over Threshold Model. Based on research, six types of Polish rural municipalities were identified in 2017. The socio-economic development level was found to vary strongly across municipalities. The highest levels were recorded in municipalities located near urban centers while the lowest levels were reported by remote municipalities.

**Keywords:** Modified Positional TOPSIS Method, Socio-Economic Development Level, Rural Municipalities.

### 1 Introduction

Territorial development is a long-term process of positive qualitative and quantitative changes. It includes economic, social and spatial processes affecting the territory considered. It is strictly related to local government units and may be examined at regional and local level. At regional level, development means an increase in the region's economic potential together with a permanent improvement in the region's competitiveness and in standards of living for the population [16]. Local development may be considered similar to regional development. The basic difference is that local

development takes place on a smaller scale and is restricted to a specific area: a small territory with its local residents. Hence, it involves changes occurring in a microregion, i.e. a local socio-territorial system which includes local administrative units (LAU).

In the US literature, local development is related to economic development [see e.g. 11, 14] while the European literature gives it a broader scope. Generally, local development means socio-economic development [see e.g. 15, 18]. Note that the assessment of socio-economic development relies on various quantitative and qualitative methods. On the one hand, analyses carried out using these methods allow for a better understanding of the socio-economic situation of local government units, which consequently can be helpful in planning their development. On the other hand, they are burdened with certain limitations resulting from assumptions and simplifications that can only partially explain the situation in a given local unit.

Parysek [13, p. 47] emphasizes that local development is a socio-economic development category which lacks strong tradition and is not backed up by well-established theories, methodologies or achievements, especially in Poland. "At least several dozen theories and concepts of various scopes, which emerged from different methodological approaches, provide a variety of explanations for the disparities in the pace of socio-economic processes across the territory" [12, p. 8]. Witkowski [21, p. 6] suggests that "each time, the direct reason for the establishment of a new approach were the disappointing results of implementing the previous one."

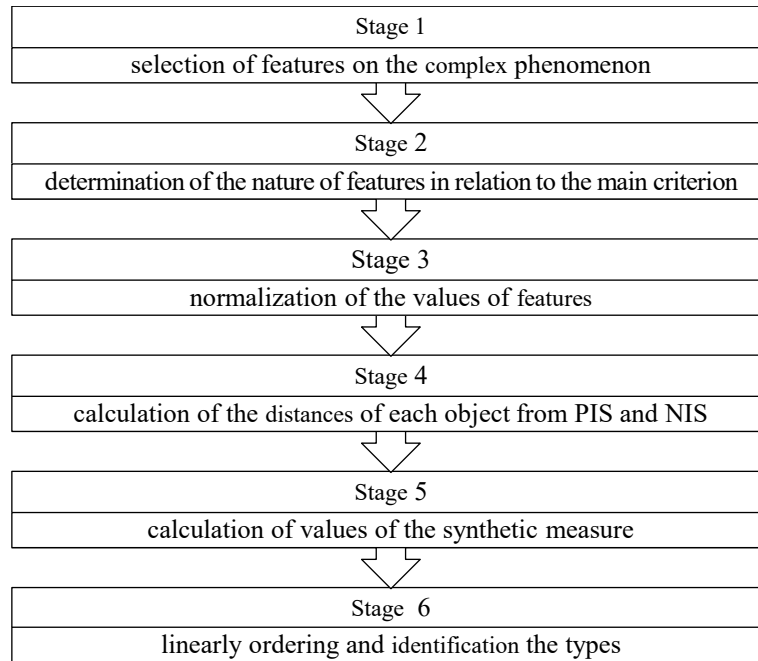
The socio-economic development level of administrative units is a complex aspect. It can be neither measured directly nor described with a single characteristic. To describe such aspects, synthetic measures are used which enable a summary description. The synthetic feature is based on many features which often are characterized by a strongly asymmetric distribution or extreme values. For the research process, this means a considerable complication which cannot be dealt with using classical methods for constructing a synthetic feature. This is because even a single outlier (very large or very small) for a given object may significantly affect the attribution of an excessively high (or low) rank in the final classification. In view of the above, the relevant research should place a stronger focus on outlier-robust methods.

The objective of this paper was to use a modified positional TOPSIS method to assess the socio-economic development level of Polish rural municipalities in 2017. The study population are rural municipalities which include only over rural areas. They were selected because they face many problems which can be effectively addressed only if these units are assessed on a comprehensive basis. This is the reason why the research on these areas is particularly important. The proposed research tool was the modified positional TOPSIS method which enables creating a synthetic feature in cases where the set of study variables includes features which are characterized by a strongly asymmetric distribution or extreme values. The study was based on 2017 data from the Local Data Bank of the Central Statistical Office [2].

## 2 Methodology

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) [6] is the most known technique for solving Multi-Criteria Decision Making (MCDM) problems. It is used to construction the ranking of objects describing by many features. This method has many advantages, particularly its classical version is simple to use. Classical TOPSIS and its modifications are popular approaches and have been widely used in various issues [1, 3, 9, 20].

We propose using the modified positional TOPSIS method to assess the socio-economic development level of rural municipalities. This method utilizes the mean excess function for identification of outliers (extreme values) of the features describing the level of socio-economic development of rural municipalities. The procedure to construct a synthetic measure, based on the modified positional TOPSIS method, includes six basic stages (Fig. 1).



**Fig. 1.** Main stages of the procedure of constructing a synthetic measure.

The first stage contains the selection of features (indicators) describing objects (rural municipalities) and the second stage includes determination of the direction of their preferences in relation to the main criterion. The choice of features is based on substantive and statistical criteria. The set of features describing the level of socio-economic development of rural municipalities usually includes strongly asymmetric items or outliers. We propose to solve this problem by using:

- methods for identifying the threshold value in the Peaks over Threshold Model (POT) to establish threshold (limit) of outliers (extreme values),
- the positional formulation of TOPSIS method, that utilize the spatial median of Weber to limit the impact of the strong asymmetry of features.

First, methods for identifying the threshold value in the Peaks over Threshold Model [see e.g. 10] was used to establish limits of extreme values. In POT, the tail of the distribution of the feature is modeled using the Generalized Pareto Distribution (GPD). The beginning of the tail is determined by establishing a threshold value ( $ul_k$ ). In this model, the starting point for the considerations is the conditional distribution of excess over  $ul_k$  of random variable  $X_k$  ( $k$ -th feature), defined as:

$$F_{ul_k}(y_k) = P(X_k - ul_k \leq y_k | X_k > ul_k) = \frac{F(y_k + ul_k) - F(ul_k)}{1 - F(ul_k)}, \quad (1)$$

where:  $y_k = x_k - ul_k > 0$ ,  $F$  – the unknown distribution function of random variable  $X_k$ . According to the Pickands–Balkema–de Haan theorem, for a sufficiently large  $ul_k$ , the distribution function  $F_{ul_k}$  is definite and is well approximated by the GPD:

$$G_{\xi, \beta}(x_k - ul_k) = \begin{cases} 1 - (1 + \xi(x_k - ul_k)/\beta)^{-1/\xi}, & \xi \neq 0 \\ 1 - \exp(-(x_k - ul_k)/\beta), & \xi = 0 \end{cases}, \quad (2)$$

where:  $\beta > 0$ ,  $x_k - ul_k \geq 0$  for  $\xi \geq 0$  and  $0 \leq x_k - ul_k \leq -\beta/\xi$  for  $\xi < 0$ . This distribution has two parameters: shape parameter ( $\xi$ ) responsible for the thickness of the tail and scale parameter ( $\beta$ ). Negative values of  $\xi$  show that the distribution has thinner tails than the normal distribution. In turn, the positive values  $\xi$  show that the distribution has fat tails, which is associated with an increased probability of extreme feature values. The correct choice of the threshold value  $ul_k$  is important, because it has an impact on the values of GPD parameter estimators. If  $N$  is the number of observations,  $N_{ul_k}$  is the number of observation in excess of  $ul_k$ , the estimator of the distribution function  $F$  is calculated from the formula:

$$\hat{F}(x_k) = 1 - \frac{N_{ul_k}}{N} \left( 1 + \xi \frac{(x_k - ul_k)}{\hat{\beta}} \right)^{-1/\xi}. \quad (3)$$

The choice of the  $ul_k$  threshold should depend on the specifics of features and their number. The methods for selecting the threshold are presented by Coles [4] and in many other publications. One of the methods is to analyze the stability of estimated GPD parameters. The second method is to analyze the chart of the mean excess function. In this method, the starting point is the conditional expected value:

$$E(X_k - ul_k | X_k > ul_k) = \frac{\beta(ul_k)}{1 - \zeta}, \quad \zeta < 1. \quad (4)$$

Due to the fact that  $\beta(ul_k)$  depends linearly on  $ul_k$  the empirical estimator of the conditional expected value also must depend linearly on  $ul_k$ . Hence the chart of the mean excess function:

$$\left\{ \left( ul_k, \frac{1}{N_{ul_k}} \sum_{i=1}^{N_{ul_k}} (x_{ik} - ul_k) \right) : ul_k < x_{k \max} \right\} \quad (5)$$

after exceeding  $ul_k$  should be linear. The lower limit ( $ll_k$ ) of the feature is determined by performing calculations for the values of the feature multiplied by minus one. In this work, threshold values were selected on the basis of an analysis of chart of the mean excess function and the empirical density of features.

The selected features describing the level of socio-economic development of rural municipalities have a stimulating or destimulating effect on the socio-economic development (stage 2). Features that have stimulating effect are called stimulants, contribute to increasing the level of the socio-economic development. In turn, features that have destimulating effect are called destimulants, contribute to decreasing the level of the socio-economic development. Features that are destimulants may be transformed into stimulants with the use of a negative coefficient transformation.

Next, values of features are normalized using modified median standardization of Weber based on threshold values of features  $ul_k$  and  $ll_k$  ( $k = 1, 2, \dots, K$ ) [cf. 7, 8]:

$$z_{ik} = \begin{cases} \frac{ll_k - m\tilde{e}d_k}{1.4826 \cdot m\tilde{a}d_k} & \text{for } x_{ik} \leq ll_k \\ \frac{x_{ik} - m\tilde{e}d_k}{1.4826 \cdot m\tilde{a}d_k} & \text{for } ll_k < x_{ik} < ul_k \\ \frac{ul_k - m\tilde{e}d_k}{1.4826 \cdot m\tilde{a}d_k} & \text{for } x_{ik} \geq ul_k \end{cases}, \quad (6)$$

where:  $x_{ik}$  – value of the  $k$ -th feature in the  $i$ -th object ( $i=1, 2, \dots, N$ ),  $m\tilde{e}d_k$  – Weber median (L1-median) vector component corresponding to the  $k$ -th feature,  $m\tilde{a}d_k = med_i |x_{ik} - m\tilde{e}d_k|$  – median absolute deviation of  $k$ -th feature values from the median component of the  $k$ -th feature, 1.4826 – a constant scaling factor corresponding to normally distributed data.

The median standardization of Weber is calculated for winsorized data. The median standardization of Weber should be used when the empirical distribution of the examined features is strongly asymmetric [7]. We adopt threshold values of features  $ul_k$  and  $ll_k$  ( $k = 1, 2, \dots, K$ ) in winsorization of data. Winsorization is a process of

replacing a determined number of extreme values of features with a constant (smaller or bigger) value.

In fourth stage the positive ideal solution (PIS) [see e.g. 23]:

$$A^+ = \left( \max_i(z_{i1}), \max_i(z_{i2}), \dots, \max_i(z_{iK}) \right) = (z_1^+, z_2^+, \dots, z_K^+), \quad (7)$$

and negative ideal solution (NIS) were calculated:

$$A^- = \left( \min_i(z_{i1}), \min_i(z_{i2}), \dots, \min_i(z_{iK}) \right) = (z_1^-, z_2^-, \dots, z_K^-) \quad (8)$$

PIS includes the maximum (ideal – the best) values of each feature. Whereas, NIS are the minimum (anti-ideal – the worst) values of features.

In next step distances for each object from PIS ( $A^+$ ) and NIS ( $A^-$ ) were calculated based on the median absolute deviation (stage 4) [23]:

$$d_i^+ = \text{med}_k \left( |z_{ik} - z_k^+| \right), \quad d_i^- = \text{med}_k \left( |z_{ik} - z_k^-| \right), \quad (9)$$

where  $\text{med}_k$  – marginal median for the  $k$ -th feature.

In fifth stage a synthetic measure is constructed based on Hwang's and Yoon's idea [6]:

$$S_i = \frac{d_i^-}{d_i^- + d_i^+}, \quad (i = 1, \dots, N), \quad 0 \leq S_i \leq 1. \quad (10)$$

The closer to 1 is the value of the synthetic measure, the higher level of development. Hellwig's method [5], Strahl's method [19] and non-model methods based on sum, mean or weighted mean are examples of alternatives to TOPSIS.

Established values of the synthetic measure are used in rank ordering of rural municipalities. Next, they allowed to identify typological classes of rural municipalities (stage 6). Identification of classes for the entire range of variation of a synthetic measure may be performed using statistical methods or arbitrary manner. In the study, it was applied an arbitrary approach based on numerical ranges of values for synthetic measure (Tab. 1).

**Table 1.** Identification of classes by arbitrary manner.

Class	1	2	3	4	5	6
Level of development of the phenomenon	very high	high	medium-high	medium-low	low	very low
$S_i$	(0.80; 1.00)	(0.60; 0.80)	(0.50; 0.60)	(0.40; 0.50)	(0.20; 0.40)	(0.00; 0.20)

### 3 Results of Research

The first step in diagnosing the state of socio-economic development at local level is to identify a set of features which characterize spatial structure in the cross-section of rural municipalities. The features were selected based on substantive and statistical analysis. Having analyzed the socio-economic situation of the rural municipalities, the set of 17 features was selected for Polish rural municipalities ( $N=1555$ ) to describe them in terms of socio-economic development. The features were grouped by five criteria: demographic and social situation, technical infrastructure, social infrastructure, economy and public finance. The criteria are represented by the following features:

Criterion 1. Demographic and social situation: share of the registered unemployed persons in the population in the working age (%) ( $x_1$ ), non-working age population per 100 persons of working age ( $x_2$ ), old-age dependency ratio – the number of persons aged (65 and over) per 100 persons of working age 15–64 ( $x_3$ ),

Criterion 2. Technical infrastructure: water supply network per 100km<sup>2</sup> (km) ( $x_4$ ), sewage network per 100km<sup>2</sup> (km) ( $x_5$ ), share of persons using wastewater treatment plants in total population (%) ( $x_6$ ), dwelling stock per 1000 population ( $x_7$ ),

Criterion 3. Social infrastructure: bed places per 1000 persons ( $x_8$ ), pupils per section in primary schools ( $x_9$ ), population per generally available pharmacy ( $x_{10}$ ),

Criterion 4. Economy: entities entered in the REGON register per 10 thous. population ( $x_{11}$ ), share of agricultural holdings with an area 15 ha and more in total number of agricultural holdings (%) ( $x_{12}$ ), share of agricultural land in total lands (%) ( $x_{13}$ ), share of built-up and urbanized areas in total area (%) ( $x_{14}$ ),

Criterion 5. Public finance: financial self-sufficiency of municipality – share of own incomes in total incomes (%) ( $x_{15}$ ), own incomes per capita (PLN) ( $x_{16}$ ), share of investment expenditure in total expenditure (%) ( $x_{17}$ ).

The studies are based on statistical data from 2017 coming from the Local Data Bank of the Central Statistical Office of Poland [2].

Five-year (2013–2017) means were calculated for feature  $x_{17}$  representing the share of investment expenditure in total expenditure. In the analysis, it was assumed that three features ( $x_1$ ,  $x_2$  and  $x_3$ ) are destimulants, two features ( $x_9$  and  $x_{10}$ ) are nominants (nominant is the type of feature which is stimulant in some range of a feature and destimulant in other its range) while other are stimulants.

Table 2 presents descriptive statistics of the features – indicators of rural municipalities in Poland in 2017 and the threshold values for the features, calculated based on a graph analysis. The features demonstrated positive skewness, except  $x_{13}$  which had negative skewness. Extremely high skewness was observed for  $x_2$ ,  $x_3$ ,  $x_5$ ,  $x_8$ ,  $x_{11}$ ,  $x_{14}$  and  $x_{16}$ . The distributions of ten features ( $x_2$ ,  $x_3$ ,  $x_4$ ,  $x_5$ ,  $x_7$ ,  $x_8$ ,  $x_9$ ,  $x_{11}$ ,  $x_{14}$ ,  $x_{16}$ ) had high positive kurtosis which means a high probability of extreme values. The distributions of these features had fat right tails. In turn, for each feature, the left tail of the distribution was thinner than that of a normal distribution or was cut off.

In order to limit the influence of outliers, the limits of outliers of features were established (Tab. 2). The calculations were performed with *fExtremes* in R [22]. Afterwards, winsorization was performed to replace tail values with calculated threshold values. Once transformed, the distributions of the features exhibited at most



moderate skewness. Only in the case of  $x_8$ , the distribution continued to have extremely high positive skewness, though considerably reduced. Next, features with a destimulating effect were converted into stimulats.

**Table 2.** Descriptive statistics and threshold values of features of rural municipalities in Poland in 2017.

$x_k$	Mean	Med	Max	Min	St. dev.	Mad	Sk.	Ex. kurtosis	$ll_k$	$ul_k$
$x_1$	5.5	4.9	18.2	1.0	2.8	1.7	1.1	1.5	×	12.0
$x_2$	60.7	60.3	113.4	45.7	4.9	2.8	2.0	16.6	51.4	70.3
$x_3$	22.6	21.9	71.8	11.7	5.0	2.9	2.2	14.8	14.1	30.3
$x_4$	100.4	90.5	533.4	0.0	60.9	33.6	1.6	5.4	×	185.7
$x_5$	45.4	24.7	656.7	0.0	64.7	18.8	3.4	15.5	×	111.4
$x_6$	40.1	35.4	100.0	0.0	28.1	20.1	0.4	-0.8	×	×
$x_7$	311.9	304.2	665.6	203.2	50.4	27.5	1.8	7.2	235.7	403.1
$x_8$	10.7	0.0	1123.3	0.0	44.7	0.0	14.5	295.0	×	45.8
$x_9$	15.1	15.1	54.1	6.8	3.0	2.0	1.4	17.1	8.8	21.3
$x_{10}$	3425.2	3332.0	18931.0	0.0	3015.4	2162.0	1.0	1.7	×	10527.0
$x_{11}$	710.9	659.1	3597.8	277.8	262.8	126.0	3.1	19.9	384.1	1107.1
$x_{12}$	12.0	9.0	51.8	0.0	10.9	7.2	1.0	0.3	×	41.6
$x_{13}$	66.0	69.3	96.5	5.5	17.9	11.4	-0.8	0.1	24.1	95.9
$x_{14}$	4.0	3.3	35.7	0.7	2.8	0.7	4.4	28.7	1.5	6.4
$x_{15}$	33.6	30.9	92.7	12.4	12.3	7.3	1.0	1.2	×	60.6
$x_{16}$	1550.4	1318.8	43781.8	537.5	1459.1	311.0	18.8	495.5	×	2867.3
$x_{17}$	15.0	14.4	56.1	2.4	5.9	3.7	0.9	2.1	×	29.4

\*Not determined threshold.

In third stage, the values of indicators were standardized using the modified median standardization of Weber. The calculations were performed with *robustX* in R [17]. The standardized values of features allowed us to calculate the distance of each rural municipality (LAU2) considered from the PIS and the NIS with the use of the median absolute deviation. Next, the values of the synthetic measure of socio-economic development of rural municipalities were calculated using the modified positional TOPSIS method. The range of variation of the synthetic measure is from 0.096 to 0.957, which allowed to more accurately determine the rank and types of rural municipalities (including six levels of socio-economic development of rural municipalities, from “very high” to “very low”) (Tab. 3).

**Table 3.** Typological classification of rural municipalities in Poland in terms of the level of socio-economic development in 2017.

Class ( $c$ )	Level of socio-economic development	$S_i$	$N_c$	%
1	very high	$\langle 0.80; 1.00 \rangle$	22	1.41
2	high	$\langle 0.60; 0.80 \rangle$	115	7.40
3	medium-high	$\langle 0.50; 0.60 \rangle$	232	14.92
4	medium-low	$\langle 0.40; 0.50 \rangle$	484	31.13
5	low	$\langle 0.20; 0.40 \rangle$	665	42.77
6	very low	$\langle 0.00; 0.20 \rangle$	37	2.38

$N_c$  – the number of objects in  $c$ -th class.

As shown by the empirical study, typological class with very high level of socio-economic development collected the 1.41% of the total number of rural municipalities in Poland. Class first, demonstrating a very high level of socio-economic development, was composed of twenty two municipalities. Most of them are located in the immediate vicinity of the cities. The proximity of the urban centers provides the rural municipalities with socio-economic benefits. The suburbanization process results in a dynamic development of the residential function of rural municipalities located in the first ring around large urban centers. The consequence is the development of infrastructure. In 2017 the first class was characterized by the highest share of own incomes in total incomes (more than 60%), the highest level of own incomes per capita (PLN 2867.3), the highest share of investment expenditure in total expenditure (24.2%). In these municipalities, the number of entities entered to the REGON register per 10 thous. population was nearly twice the Polish mean (over 1107). Also share of agricultural holdings with an area 15 ha and more in number of total agricultural holdings had the highest level (11.3%) (Tab. 4).

**Table 4.** Intra-class mean\* values of features of socio-economic development levels of rural municipalities of Poland in 2017.

Feature	Class						Poland**
	1	2	3	4	5	6	
$x_1$	2.4	3.2	3.9	4.8	5.7	7.2	4.9
$x_2$	59.4	58.5	58.2	60.1	61.5	65.6	60.3
$x_3$	15.4	18.9	20.3	21.6	23.9	28.3	21.9
$x_4$	181.4	131	105.1	94.5	79.5	72.8	90.5
$x_5$	111.4	88.8	45.8	28.9	12.3	1.5	24.7
$x_6$	88.6	68.8	52	43.1	23.4	6.6	35.4
$x_7$	351.3	309.6	303	300.5	304.9	304.5	304.2
$x_8$	12.2	6.1	3.3	0.0	0.0	0.0	0.0
$x_9$	19.4	16.6	15.3	15.0	14.8	12.8	15.1
$x_{10}$	3229.3	4062	3417.6	3740	2948	0.0	3332
$x_{11}$	1107.1	1013.4	817.0	695.5	573.5	462.4	659.1
$x_{12}$	11.3	5.6	9.2	9.7	9.6	5.9	9.0
$x_{13}$	67.2	69.3	67.4	68	70.9	74.2	69.3
$x_{14}$	6.4	6.4	4.4	3.5	2.8	2.4	3.3
$x_{15}$	60.6	52.5	43.2	33.1	25.7	18.7	30.9
$x_{16}$	2867.3	2390.8	1835.5	1401.9	1085.1	797.5	1318.8
$x_{17}$	24.2	18.5	16	14.6	13	11.4	14.4

\* The mean values of features are represented by their medians. \*\* The medians were calculated for values of features for all rural municipalities of Poland.

The second type shows high socio-economic development of 115 rural municipalities. In 2017 the class of rural municipalities was well developed in technical infrastructure and had very good demographic and social situation. In these municipalities, a large number of registered entities entered to the REGON register per 10 thous. population was also observed (over 1013, the mean for rural municipalities in Poland being ca. 659) (Tab. 4).

Average levels (medium-high and medium-low) of socio-economic development were reported by 716 rural municipalities grouped in the third and fourth typological classes (14.92% and 31.13%, respectively). In these municipalities, the majority of indicators of socio-economic development had similar to average values of features in rural municipalities in Poland. Note also that the technical infrastructure (water supply system, sewage system, wastewater treatment plants) was developed better than the average in rural municipalities in Poland (Tab. 4).

In turn, the fifth typological class, demonstrating low level of socio-economic development, was composed of 665 (42.77%) rural municipalities of Poland. These municipalities are at lower levels of technical and social infrastructure development. Rural municipalities of the fifth class reported a distinctively low level of financial self-sufficiency (less than 26%) (Tab. 4).

The sixth class with very low level of socio-economic development collected barely 2.38% of the total number of rural municipalities in Poland. These municipalities exhibited pronounced characteristics of remote areas, reflected by economic stagnation. It was noticed relatively small number of entities entered to the REGON register per 10 thous. population (ca. 462). These rural municipalities were characterized by the lowest level of own incomes per capita (barely PLN 797.5) and, at the same time, the lowest share of own incomes in total incomes (less than 19%). In these municipalities, the low levels of own incomes per capita and low shares of own incomes in their budgets resulted in the lowest share of investment expenditure in the total expenditure. This contributed to very low socio-economic development level of the rural municipalities. Also, these municipalities had a poorly developed social and technical infrastructure which exhibited certain deficiencies. In these areas, no year-round accommodation was offered and no pharmacies were available. These were mainly agricultural municipalities located away from large urban centers. The dominant role of agriculture was manifested by a considerable share of agricultural land in total land area (over 74.2%). Note however that agricultural land was mainly distributed between small farms as the share of 15 ha or larger farms did not exceed 6% (Tab. 4).

## **4 Conclusions**

If the set of feature values includes outliers, constructing the synthetic measure with the use of classical methods may result in excessively reducing the range of variation of the synthetic development indicator. As a consequence, it may become problematic to properly identify the development types of the complex aspect under consideration. The reason for these problems is that empty classes may appear if classical methods for identifying development types are used. Moreover, in the final ranking, an excessively high or low rank may be attributed to objects whose observed features include outliers. To solve these issues, an outlier-robust approach was proposed. As shown by empirical studies, the proposed approach based on the modified positional TOPSIS method properly reflected the differences in socio-economic development levels between classes of units covered by the study.

The modified positional TOPSIS was used to synthetically assess and identify the types of socio-economic development levels of rural municipalities in Poland. This is a suitable approach to determine the synthetic development measure in a case where the set of features of municipalities includes outliers or strongly asymmetrical values. The modified positional TOPSIS method is robust to outliers and to defined values of the positive ideal solution and the negative ideal solution.

The study enabled the identification of six types of socio-economic development level (from very high to very low). The largest class comprises rural municipalities at low levels. In turn, classes at very high and very low development levels are poorly represented among rural municipalities. Note also that the most developed municipalities are located near cities whereas remote areas are the least developed ones. In other words, the greater the distance from urban centers, the lower the development level of rural municipalities.

The proposed approach to assess the socio-economic development levels of rural municipalities in Poland is a universal approach that may be used for other administrative units. The proposed research approach may also be the basis for the establishment of development documents, e.g. development strategies or programs of development.

## References

1. Afsordegan, A., Sánchez, M., Agell, N., Zahedi, S., Cremadesl, L.V.: Decision making under uncertainty using a qualitative TOPSIS method for selecting sustainable energy alternatives. *International Journal of Environmental Science and Technology*, 13(6), 1419–1432 (2016), DOI: 10.1007/s13762-016-0982-7.
2. Bank Danych Lokalnych (Local Data Bank), Central Statistical Office, Poland ([www.stat.gov.pl](http://www.stat.gov.pl)).
3. Behzadian, M., Khanmohammadi Otaghsara, S., Yazdani, M., Ignatius, J.: A state-of-the-art survey of TOPSIS applications. *Expert Systems with Applications*, 39(17), 13051–13069 (2012), DOI: 10.1016/j.eswa.2012.05.056.
4. Coles, S.: *An Introduction to Statistical Modeling of Extreme Values*. Springer, London (2001).
5. Hellwig, Z.: Zastosowanie metody taksonomicznej do typologicznego podziału krajów ze względu na poziom ich rozwoju oraz zasoby i strukturę wykwalifikowanych kadr (Taxonomic method application for the typological division of countries in terms of their development level and the resources and structure of qualified personnel). *Przegląd Statystyczny*, 4, 307–327 (1968).
6. Hwang, C.L., Yoon, K.: *Multiple attribute decision-making: Methods and applications*. Springer, Berlin (1981).
7. Lira, J., Wysocki, F., Wagner, W.: Mediana w zagadnieniach porządkowania obiektów wielocechowych (Median in the ordering problems of multi-feature objects). In: Paradysz, J. (ed.), *Statystyka regionalna w służbie samorządu terytorialnego i biznesu*, pp. 87–99. Akademia Ekonomiczna w Poznaniu, Poznań (2002).
8. Łuczak, A., Just, M., Kozera, A.: Application of the positional POT-TOPSIS method to the assessment of financial self-sufficiency of local administrative units. In: Cermakova, K., Mozayeni, S., Hromada, E. (eds.), *Proceedings of the 10th Economics & Finance Conference*, Rome, pp. 610–621. International Institute of Social and Economic Sciences

- and International Society for Academic Studies, z.s., Prague (2018) ([www.iises.net/proceedings/10th-economics-finance-conference-rome/table-of-content](http://www.iises.net/proceedings/10th-economics-finance-conference-rome/table-of-content)).
9. Mardani, A., Jusoh, A., Zavadskas, E.K.: Fuzzy multiple criteria decision-making techniques and applications – Two decades review from 1994 to 2014. *Expert Systems with Applications*, 42(8), 4126–4148 (2015). DOI: 10.1016/j.eswa.2015.01.003.
  10. McNeil, A.J.: *Extreme Value Theory for Risk Management*. Departement Mathematic ETH Zentrum, Zurich (1999).
  11. Morgan, J.Q.: *The Role of Local Government in Economic Development: Survey Findings from North Carolina*. UNC School of Government, Chapel Hill (2009). Show all authors
  12. Obszary metropolitalne jako bieguny wzrostu – analiza wpływu wykorzystania funduszy strukturalnych na rozwój społeczno-gospodarczy regionów (Metropolitan areas as growth poles – analysis of the impact of the use of structural funds on the socio-economic development of regions). Kisiała, W., Stępiński, B. (eds.), Uniwersytet Ekonomiczny w Poznaniu, Poznań (2012).
  13. Parysek, J.J.: *Podstawy gospodarki lokalnej (Fundamentals of the local economy)*. UAM w Poznaniu, Poznań (1997).
  14. Reese, L.A., Rosenfeld, R.A.: Local Economic Development in the United States and Canada: Institutionalizing Policy Approaches. *The American Review of Public Administration*, 34(3), 277–292 (2004). DOI: 10.1177/0275074004264293.
  15. Rosner, A., Stanny, M.: Socio-economic development of rural areas in Poland. EFRWP, IRWiR PAN, Warszawa (2017).
  16. *Słownik Rozwoju Regionalnego (Dictionary of Regional Development)*. Kozak, M., Pyszkowski, A., Szewczyk, R. (eds.), Polska Agencja Rozwoju Regionalnego, wyd. III, Warszawa (2000).
  17. Stahel, W., Maechler, M.: Package “robustX” (2012).
  18. Stanny, R., Rosnar, A., Kozdroń, E.: Changes in the Spatial Distribution of the Level and Dynamics of Socio-Economic Development of Rural Areas in Poland. *Wię i Rolnictwo*, 4(173), 29–47 (2016). DOI: 10.7366/wir042016/02.
  19. Strahl, D.: Propozycja konstrukcji miary syntetycznej (A proposal for the construction of a synthetic measure). *Przegląd Statystyczny*, 25(2), 205–215 (1978).
  20. Velasquez, M., Hester, P.T.: An Analysis of Multi-Criteria Decision Making Methods. *International Journal of Operations Research*, 10(2), 56–66 (2013).
  21. Witkowski, J.: Ewolucja koncepcji rozwoju od końca II wojny światowej do roku 2000 (Evolution of the development concept from the end of World War II to the year 2000). *Dialogi o rozwoju*, 2, 5–26 (2008).
  22. Wuertz, D., Setz, T., Chalabi, Y.: Package “fExtremes” (2017).
  23. Wysocki, F.: Metody taksonomiczne w rozpoznawaniu typów ekonomicznych rolnictwa i obszarów wiejskich (Taxonomic methods in recognizing economic types of agriculture and rural areas). Uniwersytet Przyrodniczy w Poznaniu, Poznań (2010).

## Ethical Dimension in the Education of Future Managers

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**Abstract.** The paper focuses on the basics of business ethics teaching and the way it is taught at the Faculty of Informatics and Management, University of Hradec Kralove, Czech Republic in the study programmes of Financial Management and Management of Travel and Tourism. The theoretical basis consists mainly of the philosophical disciplines, whose applied output business ethics is. In addition to the theoretical knowledge, practical lessons and problems related to managerial competencies are included in the course. Based on the frequency analysis of the essential motifs, the student's seminar papers looking into the hypothetical imperative in the manager's activities and the casuistic real situations are examined. In these situations, decision-making and behaviour of the manager are captured and evaluated by students and sometimes also confronted with students' dissenting opinions and their proposals of more suitable solutions. The student's opinion, both agreeing and disagreeing, is justified. It has been shown that students understand the manager's asymmetric responsibility, and one of the most important motifs is the emphasis on linking the professional competence and ethical approach of the manager. The most frequently mentioned values are fairness and decency in the manager's behaviour and actions. The seminar topic "Ethical Audit" is based on the results students' case studies. This contribution contains three case studies illustrating the type of student texts we worked with.

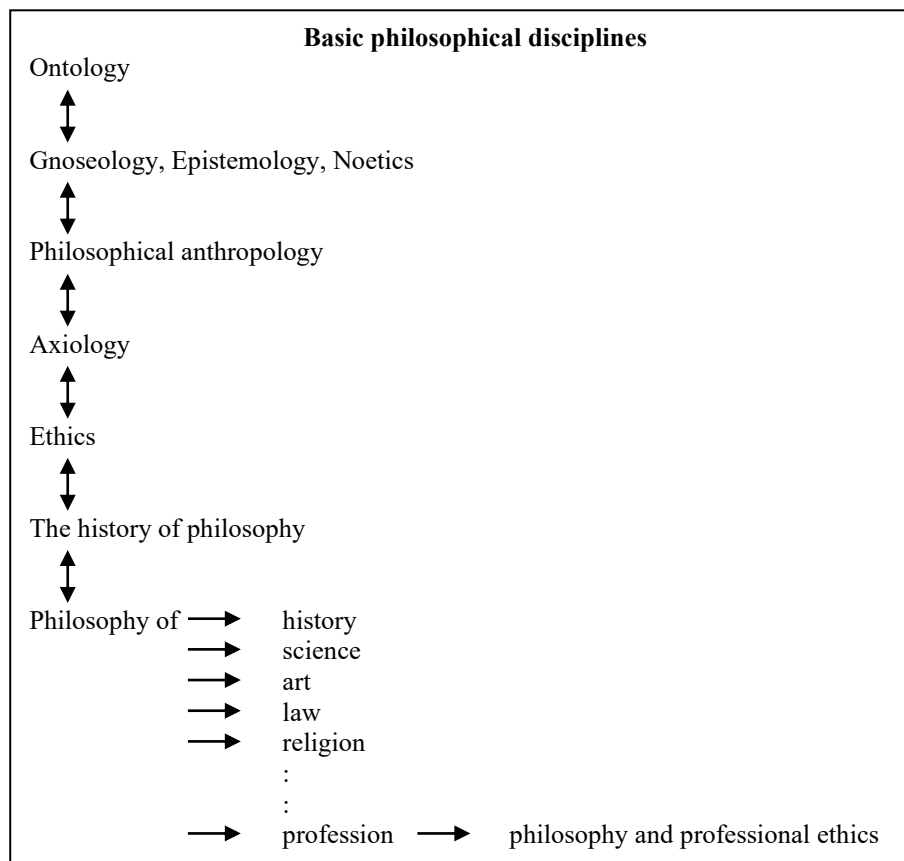
**Keywords:** Business Ethics, Education, Case Studies, Hypothetical Imperative, Frequency Analysis.

### 1 Introduction

Philosophy and professional ethics are reflected in ethical codes of professions, companies, institutions and organizations. Requirements placed on employees and their superiors as well as a particular management style are an integral part of ethical codes of conduct. Unfortunately, even though ethical codes of conduct have become common, there have been a lot of examples of corporate scandals and unethical things happening in business organizations (see e.g. [4] or [2]). As a result, most universities offering business courses have implemented into their curricula courses of business ethics. Some authors, for example [4], suggest that ethics education can and does improve students' ethical awareness, sensitivity as well as their moral reasoning. It therefore matters whether there are business ethics courses or not.

Other authors, e.g. [2], claim that universities, in particular their business study programs, do little to help students develop morally, which contributes to the some managers' amoral decision making leading to corporate ethical scandals. [6] conclude that there are no significant differences between students who have taken a course of business ethics and those who have not.

Consequently, it is relevant to ask, like e.g. [5] do, what should be changed in ethics education. [2] believe that students must be encouraged to practise problem solving instead of receiving ready-made solutions to moral issues. [1] suggest and develop an alternative intuitive, reflective, identity-based approach to teaching business ethics, which requires students to write a series of reflective exercises, and maintain that their approach helps strengthen their students' moral judgement much better than the traditional rule-based approach.



**Fig. 1.** Philosophy and professional ethics

The authors of this contribution are responsible for teaching business ethics at the Faculty of Informatics and Management (FIM), University of Hradec Kralove (UHK), the Czech Republic. The study programmes of Financial Management and

Management of Travel and Tourism at FIM UHK include a course of business ethics. This course is based on the theoretical foundations of ethics as a philosophical discipline and show a logical connection with other philosophical disciplines, as shown in Fig. 1. For further details it is possible to see e.g. [3] and [8].

The authors of this contribution claim that teaching business ethics to future managers is important. On the other hand, they favour problem-based and reflective approach to solving ethical problems. That is not to say that the traditional ruled-based approach is not used at all. FIM students are supposed to know the basics of ethical theory but at the same time they are required to be able to discuss about and/or reflect on real ethical problems they may and do encounter in their everyday life. The text below is based on their reflective written exercises.

## 2 Methodology

Students in their individual reflective written exercises formulate ideas and insights into the constitution of ethics as a philosophical discipline. The most successful results include the formulation of hypothetical imperatives (Immanuel Kant) for entrepreneurs and case studies describing their experience either from either their permanent employment (students of the combined form of study) or from their part-time jobs. The results of the empirical survey were obtained in the academic year 2017/2018 (82 individual works were evaluated) and in the academic year 2018/2019 (20 works have been evaluated so far). Based on frequency analysis, individual motifs were assigned to typical formulations. Most works contained more than one motif.

## 3 Results

Students' wording of hypothetical imperatives clearly demonstrates that they fully understand and capable of applying ethical theory. Students also seem to have fully understood the importance of reciprocity and responsibility. It can be concluded that they also understand the issue of asymmetric accountability. We think it is no coincidence that student determine as the most substantial motifs fairness, respect, and justice. As it is shown in Table 1, students seem to realize the importance of entrepreneurs' ability to behave ethically themselves in the first place. Only then can they expect others, i.e. their employees, to do the same.

**Table 1.** Hypothetical imperatives for entrepreneurs - the most typical answers.

If you want employees to work well, create a favourable working environment.	81
If you want people to behave to you decently, you have to be decent to them.	81
If you require fair behaviour in your company, you have to act fairly.	79
If you want others to listen to you, you have to listen to them, too.	65
If you want to be successful, you have to set goals you want to achieve.	44
If you want to have an active and reliable team, then you have to motivate workers.	42



If you want to achieve business goals, you must develop determination, creativity, self-confidence, and pursue honesty and justice.	40
If you want to have satisfied customers, you have to care for their satisfaction.	37
If you want to lure customers, your company must have a good reputation.	37
If you want to attract customers, you have to invest in PR.	28
If you want your company to have a good reputation, you have to deal with customers duly.	25
The success of the company requires that the work done is fairly rewarded, and therefore you cannot prioritize employees, over- or underestimate them.	25
If you want the economic environment for business to be favourable, behave fairly also in relation to competition.	19
If you want other people to treat you with respect, you have to treat them in this way, too.	16
If you want to get respect, you cannot act arrogantly, you cannot bully employees, you cannot act as a racist or sexist.	15
If you want your employees to be involved in the best possible performance, you have to explain them clearly why their good work is important.	12
If you want to succeed in business and team management, you have to be able and willing to take responsibility and the risk of decision making.	9
If you want to be a benefit to your company and yourself, you must be able to sum up the results and the part you played in getting them.	3

In analysing 102 case studies, Table 2 shows the following ten types of situations arose as the greatest problems in senior management:

**Table 2.** The evaluation of case studies.

The abuse of power by superior officers in relation to their subordinates (see case study 1).	89
The lack of respect for the possibilities and responsibilities of employees in relation to the organization of work (see case study 2).	87
Unfair evaluation of employees, not just in respect to their financial rewards.	87
Poor or inadequate internal communication.	72
Bullying at the workplace.	69
Manifestations of disrespect to employees, arrogance, vulgar speech.	65
Deficiencies in the development of corporate education in the field of professional ethics and appropriate behaviour in relation to colleagues and customers (see case study 3).	53
Lack of self-reflection and self-criticism in superiors.	47
Preferring personal interests and relationships over fair dealing in the company, giving preference to friends.	35
Ageism - specifically unfavourable manifestations in relation to young workers who have not yet had enough experience – e.g. humiliation, exploitation, abuse.	27

All case studies reflected the issue of justice. The students are very sensitive to injustice, and therefore lessons of Business Ethics deal with the issues of justice in theoretical context, especially in relation to Rawls: "Social and economic inequality must be adjusted to expand to all positions and ranks." [7].

Furthermore, we examine compensatory justice, procedural justice and distributive justice. In particular, procedural justice, which identifies correct decision-making procedures, practices and agreements, and distributive justice - affecting the distribution of benefits, rights and obligations, legislation and ethical codes - are in the centre of attention. Based on particular case studies, we focus on principles and values as non-objective challenges of specific ethical codes and draw conclusions for managerial decision-making. The above mentioned theoretical basis is then used in the final essay, which is a reflection on oneself as a future manager.

### **3.1 Case Study 1**

This summer, I started to work as a shop assistant in a shop selling video games at a local business centre. Originally I was supposed to act as a part-timer, that is as an employee who only sells. Later the situation changed and I was considered a full-fledged employee.

The work is very demanding on multitasking and the tasks the employee has to perform during the day are many. I was at work almost every day, sometimes on a twelve-hour shift. My supervisor originally promised me that I would only make six-hour shifts to sell the goods and get the hourly wage. The situation changed after a few weeks, and work began to increase as money dwindled. The supervisor began to abuse his powers and forced me to do more work, which I was not familiar with (complaints, orders, support), under the threats of not paying my salary. I was not only me, but also my full-time colleagues.

Another issue is breaking promises of the organization concerning sales and holiday bonuses.

I would like to draw attention to the behaviour of this organization, which is not able to pay its employees properly and constantly, and exerts pressure on managers who reach the goals of the corporation by bullying their subordinates. Such behaviour has discouraged me not only as a part-time employee but also as a potential customer.

I personally see this behaviour as unacceptable. To treat employees in a way that changes their employment and pay terms without proper notice or after agreement, just as it suits the organization, seems to me to be unfair. In most cases, it was a violation of a work contract by the employer. The company should deeply reflect on its approach to its employees.

### **3.2 Case Study 2**

As a topic of my case study on Business Ethics, I chose an example from my own experience. It will discuss the unethical behaviour of a supervisor, specifically a manager, when I was working as a part-timer.

As I have already mentioned, I would like to describe the situation that happened to me when I worked as a part-timer for a cinema. I was looking for a part-time job at the beginning of this year as I wanted to earn some extra money during my university studies. I was thrilled when I was selected after an interview in the cinema as a messenger, later cashier and bartender. As it is usual in new jobs, whether full-time or part-time, I had to undergo the initial training and everything looked rosy for a month or so. Later, I realised that it is not as great as I had thought, particularly when it comes to the behaviour of managers.

The shifts were registered electronically, we checked our time options and the manager was to fairly divide the shifts. Suddenly I started to receive text messages, especially in the evenings, asking me to come to work the next day, because some colleague could not come for an unspecified reason. This lasted several months. In the case of my refusal, I was threatened to be dismissed, which I could not afford. This practice is clearly unethical to the employee. When I decided to challenge the manager with the fact that it was not proper to send text messages around midnight, I was told that I was there only as a part-timer and that they could find someone else. When I came to work the next day, I had to do both my usual job and the work of the colleague, who could not come to work. The work was double, but it was not appreciated. I was just blamed for not doing anything.

I would deal with this very differently if I were a manager. I would approach people with respect. I would ask my subordinates in a reasonable afternoon hour, whether or not they could come the next day. I would motivate them by a financial reward for overtime. They would also be rewarded by the good feeling that we helped someone in need. I would never threaten anyone with sacking, when they do not arrive at an unplanned shift. It looks as if the managers did not think we could have some private life and some plans for the day off.

### **3.3 Case Study 3**

The situation that I would like to describe here happened to me about a week ago when I was buying shoes in a shoe shop. The first thing that struck me when I arrived at the shop was the staff who were talking together in a rather inappropriate, even vulgar way, and no one seemed to notice that a new customer had arrived. I needed advice on the choice of shoes, but I did not dare to disturb their fun in a closed circle. Finally, I picked a pair of shoes by myself and went to the cash desk. I waited there for a few minutes before one employee noticed that I would like to pay. When she came to the cash desk, I was shocked as the lady was wearing red contact lenses, which looked rather scary and left me astonished. Just for clarification, it was a well-known brand, whose outlets are located in almost every shopping centre. Therefore, I expected a somewhat more professional approach. In the end, the shop assistant annoyed me even more by the way she was trying to sell me a shoe cleanser. I had to refuse buying it at least three times.

All in all, it was a really unpleasant purchase and, in my opinion, an inappropriate behaviour towards the customer through and through. From my point of view, the shop assistant should not have worn red contact lenses as it was really frightening.

Moreover, her and her colleagues' approach to me as their customer was far from pleasant.

## 4 Conclusion

Discussions on the creation of hypothetical imperatives and on frequency analysis of case studies in seminars have shown that students understand the interdependence of social, economic, psychological and ethical facets involved in managerial positions. At the same time, we were able to follow these discussions up with the issue of ethical audit and then we formulated essential criteria for positive perception and evaluation of the company, enterprise, institution. Once again, justice, fairness, responsibility and decency were dominant features.

Business Ethics is part of the training of entrepreneurs and managers. Economic considerations cannot be reduced to the way of thinking that only lead us to short-term profits. The success of the company is supported by its ethical conduct and is based on the responsible conduct of qualified and motivated personnel.

## References

1. Gu, J., & Neesham, C.: Moral identity as leverage point in teaching business ethics. *Journal of Business Ethics*, 124(3), 527–536. (2014). DOI: 10.1007/s10551-013-2028-0
2. Hummel, K., Pfaff, D., Rost, K.: Does Economics and Business Education Wash Away Moral Judgment Competence? *Journal of Business Ethics* (2018) 150: 559. <https://doi.org/10.1007/s10551-016-3142-6>, (2018).
3. Kacetl, J.: *Obchodní a podnikatelská etika*. (Business Ethics). Gaudeamus, Hradec Králové. (2011).
4. Lau, C.L.L.: A Step Forward: Ethics Education Matters! *Journal of Business Ethics* (2010) 92: 565. <https://doi.org/10.1007/s10551-009-0173-2>
5. Neesham, C., Gu, J.: Strengthening Moral Judgment: A Moral Identity-Based Leverage Strategy in Business Ethics Education. *Journal of Business Ethics* (2015) 131:527–534 DOI 10.1007/s10551-014-2483-2
6. Peppas, S. C., Diskin, B. A.: College courses in ethics: do they really make a difference? *International Journal of Educational Management*, 15(7), 347–353. (2001). doi:10.1108/09513540110407947
7. Rawls, J.: *The Theory of Justice*. Harvard University Press, Cambridge (Mass.), (1971).
8. Semrádová, I.: *Inspirativní etické koncepce*. (Inspirational ethical theories). WAMAK CZ s.r.o. pro nakladatelství Miloše Vognara M&V, Hradec Králové. (2012).

## Educational Activities of Agritourism Farms in Poland

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**Abstract.** The paper presents the educational offer of agritourism farms in Poland. The research was carried out at the Department of European Policy and Marketing of the Warsaw University of Life Sciences (SGGW) in 2017 using the diagnostic sampling method and a questionnaire technique. The educational activity of the agritourism farms was evaluated, taking into account such factors as: economic and structural conditions, natural and cultural qualities, tourism development, thematic profiles of farms: education, production, service or care. At present, we have unlimited access to a lot of information through the development of new technologies. Certain knowledge is therefore required to understand educational processes, relations with the environment and setting new requirements for agritourism farms that wish to expand their activities in the field of educational challenges. The surveyed agritourism farms offer their customers a very wide and diversified range of educational profiles. The most frequently offered activity profiles of farms include: sport and recreation, arts and crafts, agricultural and farming activities as well as traditional food.

**Keywords:** Agritourism, Agritourism Farms, Educational Offer.

### 1 Introduction

Currently, there are significant changes, both social, political and economic in Poland. These apply to many branches of the country's economy. New situations and challenges have also affected the Polish countryside. For many families living in the countryside, new opportunities emerged for seeking additional sources of income, self-employment, and thus new jobs, which would improve the financial situation of not only farmers, but residents of entire villages or boroughs [15].

When providing services for tourists, there is a great emphasis on creativity, innovation as well as education and development of human capital. This will allow to achieve economic and social benefits from running agritourism and working for the benefit of the local community [1, 8, 9].

In many European countries, educational activities are carried out using farms. In France, in 740 educational farms, the range of organized activities is determined by the

farmer's family, who prepare such activities and carry them out together with youths or children [3]. In 2010, there were 19,973 farms in Italy offering various services to tourists. Agritourism is concentrated in two regions: Trentino and Tuscany. South Tyrol is a region which intensively develops agritourism activity. The offer of the farms is very diverse, ranging from small family farms to luxury facilities, offering services of the highest quality, and in particular [12]:

- owners who live in the city, even at a large distance, own a farm or several independent houses, which have been transformed into independent apartments, each of them with a kitchenette, and a swimming pool and other facilities complement the offer. Relations with guests are minimal and the property is managed by an administrator;
- owners of large mansions, even a castle, offering luxurious rooms, elegantly furnished common spaces (reading room, piano, etc.); there is an on-site swimming pool, gym, spa, horse riding. Highly qualified staff manages the entire company, and the presence of the owner is occasional;
- members of former production cooperatives, in which available buildings have been transformed into rooms and apartments, catering facilities and restaurants. The members of the cooperative participate in the implementation of various tasks, from management to reception, through cooking, restaurant service, etc.,
- owners of medium and large farms, offering rooms and apartments, common spaces, a small swimming pool, a restaurant; most of the work is done by the family members;
- small farmers, offering modestly furnished rooms and apartments, with a small dining room where the guests and the family sometimes eat together. The external equipment is minimal;
- educational farms, designed for urban children, offer themes related to nature, agriculture, food and nutrition, and are usually managed by cooperatives or farmers;
- organic farms, usually managed by cooperatives or small farmers.

The aim of the article is to present the thematic diversity of selected agritourism farms for educational services provided.

## 2 New Functions of Farms

Agritourism fulfils many important functions both for residents of urban and rural population [7, 10]. Those functions should be understood as tasks and duties to be performed and results arising from their implementation. In their paper entitled *Agritourism*, M. Sznajder and L. Przezgórska distinguish the following functions: income, employment, use of free housing resources, activation of rural areas, conservation of natural resources as well as leisure, recreational and educational functions of the urban population [14]. In the study *Rural tourism and education – various levels, different dimensions*, the authors M. Marks, A. Jaszcak and E. Marks divided agritourism functions in relation to tourists and farm owners [13]: Educational functions of agritourism in relation to tourists are as follows:

- getting to know the lifestyle and work of farmers,
- the opportunity to participate in the production and acquisition of food,
- participating in the preparation and consumption of regional dishes,
- learning about the cultural heritage of the Polish countryside,
- learning about local customs, customs and folk traditions,
- crafts and handicrafts,
- the opportunity to shape appropriate attitudes towards nature and landscape protection.

Educational functions of agritourism in relation to farm owners include the following areas:

- assimilation of positive role models – the cultural aspect and an increase in the standard of living,
- broadening social contacts,
- the possibility of social and professional promotion,
- new perspectives for the rural population,
- integration of the rural environment,
- increase in moral tolerance.

Contemporary rural areas are becoming more and more attractive tourist destinations and are used for relaxation and recreation. Trips to the countryside for leisure purposes have become a way to spend holidays or long weekends. The country is a very attractive destination due to the natural, clean environment, beautiful landscapes, the opportunity to learn about farms and participate in the life of the hosts, healthy, natural food, learning about farm animals, etc. It is especially popular for farms with a small area (up to 10 ha) with a multidirectional production and breeding. Such farms account for 66% of all rural accommodation facilities participating in the categorization system [6].

In many educational programs implemented on farms, attention is also paid to the cultural aspects of the regions. In this case, the travellers' interests focus on the rich past of residents or areas, preserved and reflected in monuments, historical surroundings, traditional architecture and folk handicrafts [11].

Also, many agritourism farms organize culinary workshops, during which tourists participate in the process of preparing healthy, regional meals, and also learn about regional cuisine "from the inside". In culinary tourism, the local and ecological origin of food products is important, e.g. vegetables and fruits from own organic farming, meats smoked in own smokehouses according to regional regulations, etc. [4].

Through their offer, educational farms promote the countryside, its natural and cultural values. An innovation in the subject of educational tourism is the emergence of Educational Homesteads [2], whose task is to promote folk traditions and culture, disseminate the idea of education in an agricultural household and arouse the curiosity of getting to know the farmer's work and rural life.

To sum up – the functions of agritourism are very important for both tourists and guests and for farm owners. Some of these functions overlap or complement each other. It is difficult to identify which are more important and which are less important. Each has a different but very important role.

### **3 Methodology and Goal of the Paper**

The aim of the article is to present the thematic diversity of selected agritourism farms for educational services provided.

The research was carried out at the Department of European Policy and Marketing of the Warsaw University of Life Sciences (SGGW) [5] in 2017 using the diagnostic sampling method and a questionnaire technique. The research tool was a questionnaire, which consisted of 19 questions regarding the offer of agritourism farms, educational profiles, ideas for expanding the educational offer and the educational programs themselves.

120 questionnaires for randomly selected owners of agritourism farms were sent via e-mail. 57 correctly completed surveys were received, including: 5 surveys from Mazowieckie Province and 4 surveys from agritourism farms from Warmińsko-mazurskie, Świętokrzyskie, Podkarpackie, Pomorania, Lubelskie, Opolskie, Kujawsko-pomorskie, Śląskie, Lubuskie, Wielkopolskie, Małopolskie, Lower Silesia and West Pomorania Provinces. The collected research material was subjected to statistical analysis. The results obtained from the research were described and presented in the form of tables and graphs.

### **4 Educational Household in the Light of the Research Results**

The respondents were asked to indicate how they understood the term “educational farm”. The research conducted showed that the respondents mostly associate this concept with the educational offer that such farms propose. The majority (14%) of respondents think that it is an agricultural farm in which the guests actively participate in agricultural work. Also, the same number of respondents recognize an educational household as one conducting educational classes. According to the respondents, the relaxation at the farm and staying in an ecological, clean environment (6 responses each) are also assigned to the idea of educational farm. In the opinion of the respondents, an educational farm is also one that receives guests, an agricultural farm that receives guests and offers accommodation as well as a farm whose main purpose is education (5 responses each), a farm with traditional regional cuisine and a farm with livestock (4 responses each).

According to 5.3% of respondents, the term “educational farm” is strictly defined by law. Two people associated such a farm with the organization of “Green Schools”, and one as a farm offering leisure away from the city (see Tab. 1).

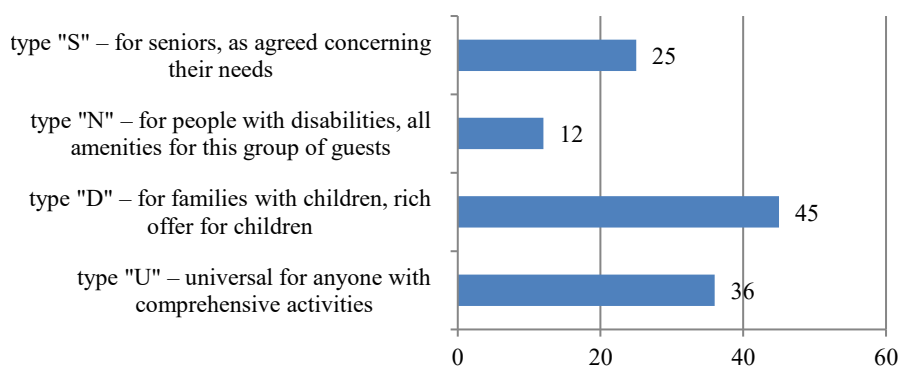
The respondents were asked if they had an educational offer on their agritourism farm. The vast majority (88%) of agritourism farms have an educational offer targeted at customers, and only 12% do not have such offers.



**Table 1.** Educational farm according to the respondents.

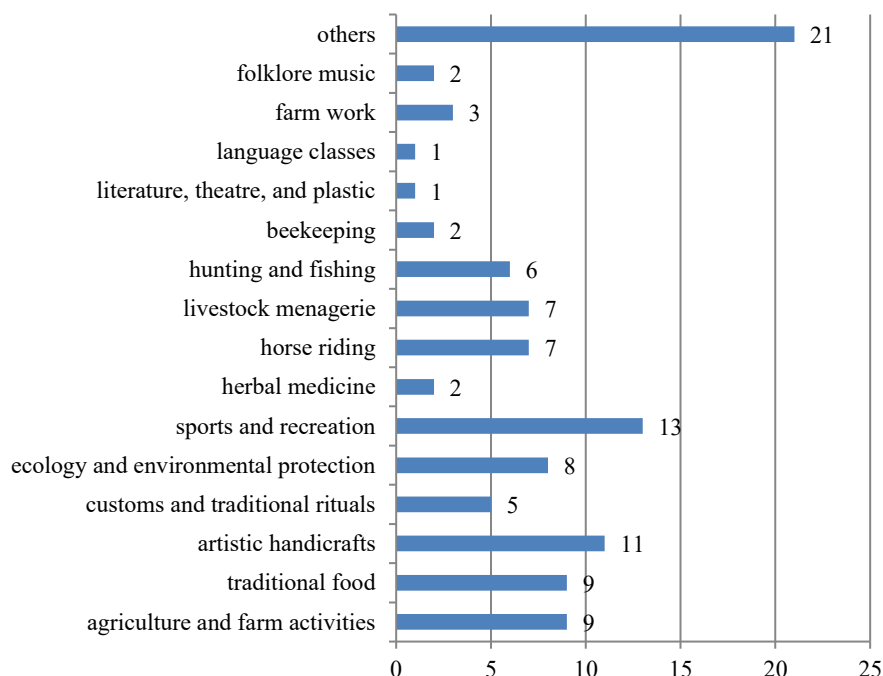
The respondents' answers	Number of answers	%
Farm household receiving visitors	5	8.8
Farm household receiving visitors with accommodation	5	8.8
What the law says	3	5.3
Farm household in which visitors actively participate in agricultural work	8	14.0
Relaxation at the farm	6	10.5
Staying in an ecological, clean environment	6	10.5
A farm with traditional regional cuisine	4	7.0
A farm offering educational activities	8	14.0
Organizing "Green Schools"	2	3.5
A farm with livestock	4	7.0
A farm whose main purpose is education	5	8.8
A farm offering leisure away from the city	1	1.8

The respondents were asked to indicate which customers (recipients) the agritourism farm is aimed at, and thus – who is the offer addressed to? The research conducted showed that the most offers are targeted at families with children. Farms with a comprehensive business profile came in second (see Fig. 1).



**Fig. 1.** Customers of agritourism farms. \*more than one answer could be selected.

With consideration to the preparation of a good educational offer, the respondents were asked to indicate which educational profiles are offered to guests in their agritourism farms. This was a multiple-choice question (see Fig. 2).

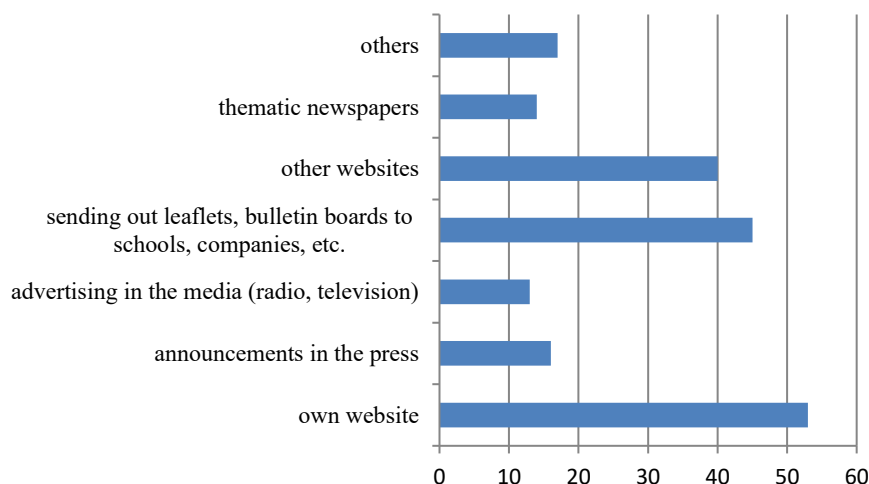


**Fig. 2.** Educational profiles of farms offered to guests. \*more than one answer could be selected.

Among the 15 educational profiles proposed, the most frequently mentioned profile was sports and recreation. Artistic handicrafts, agriculture and farm activities as well as traditional food came next in the list. The least popular educational offers among the surveyed agritourism farms were literature, theatre, art and language classes. The “others” option was chosen by 21 respondents.

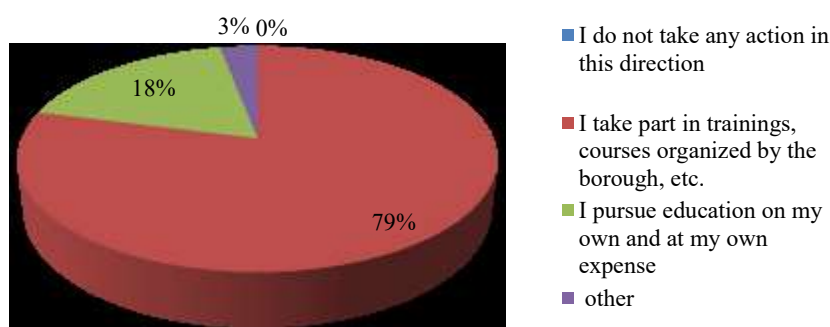
The respondents were also asked about the promotion of the farm. The purpose of the question about the promotion of the farm was to get information on whether and how hosts promote their farms and what means they use for this purpose. The results are shown in Figure 3.

53 out of 57 respondents have their own website. The potential of the Internet is a versatile tool of promotion and communication, used not only in educational activities. Agritourism farms use the Internet to build their own image. 45 out of 57 surveyed farms use promotion in the form of leaflets distribution. The least popular form of promoting the farm is advertising in the media (radio and what is certainly associated with very high costs: placing advertisements in thematic newspapers and the press).



**Fig. 3.** Promotion of the farm.

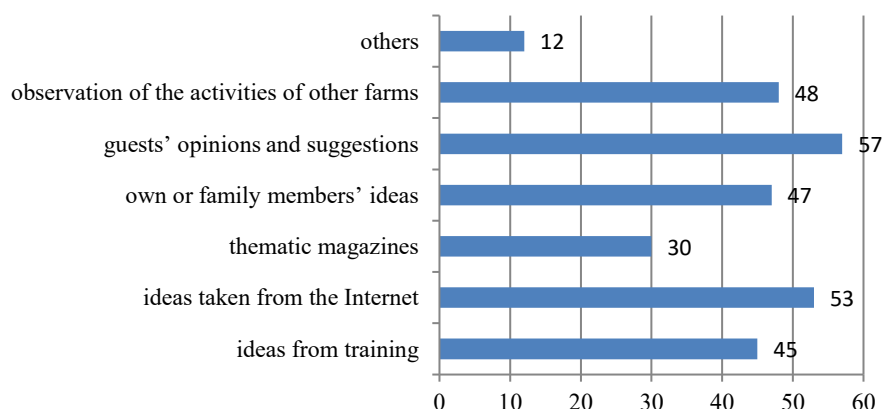
The educational function of an agritourism farm should include knowledge about the development of agricultural production, new solutions in the field of animal husbandry or new species and strains of plants. Therefore, the respondents were asked to indicate how they developed their knowledge in this area. The respondents had only one choice of answer in the field of broadening their knowledge of agritourism (see Fig. 4).



**Fig. 4.** Knowledge in the field of agritourism.

The vast majority of the surveyed take part in courses and training organized by the borough councils and Agricultural Advisory Centres. 18% of the respondents pursue education on their own and at their own expense. 3% of respondents broaden their knowledge in another way. There are no people among the respondents who do not take any steps towards expanding knowledge in the field of agritourism.

All farmers participating in the study take their ideas for expanding the educational offer from the opinions and suggestions of guests. As many as 53 of the surveyed farmers draw ideas for extending the educational offer from the Internet. 47 respondents use their own ideas and those of their family members; another 48 farms use observation of the activities of other farms. The knowledge from training is used by 45 respondents. The “others” option was selected by 12 respondents (see Fig. 5).



**Fig. 5.** Ideas for expanding the educational offer.

81% of agritourism farms have a special programme for the youngest guests. Ordered thematic blocks addressed to the youngest are presented in Table 2.

Data analysis shows that the educational offer for children is relatively diverse. Most frequently, there are classes related to the process of baking bread (10 farms offer such an educational program). The subject of beekeeping (6 farms) and the ‘seasons of the year on an agritourism farm’ (6 farms) are equally popular.

**Table 2.** Educational programmes targeted at the youngest.

Educational programme	Number of households undertaking such programmes
“From grain to bread”	10
“Tissue paper world” – products from tissue paper	3
“The horse in the household”	4
Lesson about milk	6
Lesson about cereals and grain	4
Gluing and clay pottery	4
Christmas decorations from salt mass	3
Honey – how it is made; bees, apiaries	6
Agriculture and farming activities	4
4 seasons at the farming household	6
Learning about farming livestock	6

The lessons about milk and farm animals are also offered by 6 farms. The lessons about grain, gluing and clay pottery products as well as agriculture and farm classes are offered by 4 agritourism farms).

## 5 Conclusion

The aim of this paper was to examine randomly selected agritourism farms in terms of the educational offer that they have and the thematic variety of various educational offers. 57 agritourism farms from all over the country participated in the study. Research has shown that 88% of surveyed agritourism farms have some kind of educational offer addressed to their customers. Only 45 out of the 57 surveyed farms direct their offer to families with children and specialize in this.

The surveyed agritourism farms offer their customers a very wide and diversified range of educational profiles. The most frequently offered activity profile of farms are: sport and recreation, arts and crafts, agriculture and farm activities as well as traditional cuisine. The researched farms try to match their educational profiles to individual age groups of the customers. Another thematic scope is offered to the youngest and yet another to high school students and adults. As many as 81% of the households participating in the study have a special programme addressed to the youngest age group. Most often, these are thematic blocks closely related to the farmers' work, e.g.: the process of baking bread, the horse on the farm, milk lesson, cereals, farm animals, 4 seasons in a farm yard, honey and beekeeping.

## References

1. Balińska-Grzelak, A.: The Role of Social Participation in the Stimulation of the Development of Tourism. Scientific Papers of Szczecin University, Economic Problems of Tourism, Issue No. 738, 14-17 (2012).
2. Bogusz, M., Kania, J.: Educational Homesteads as Examples of Innovative Entrepreneurship. In: Jęczmyk, A., Uglis, J., Maćkowiak, M.: Rural Tourism. Economic and Marketing Issues, vol. 1, published by Wieś Jutra Publishing House, Poznań (2016).
3. Dziasek-Kmita, E.: Wprowadzenie do zagadnień edukacji w gospodarstwie rolnym, Wydawnictwo Centrum Doradztwa Rolniczego w Brwinowie, Oddział w Krakowie, Kraków (2011).
4. Gutkowska, K., Gajowa, K., Piekut, M.: Possibilities for the Development of Culinary Tourism in Poland, Progress in Food Processing Technology, Issue No 2 (2015).
5. Grządziela, P.: Educational Activity of Agritourism Households in Poland, A Master's Thesis written at the Department of Marketing and European Politics, SGGW, Warsaw (2017).
6. [http://ksow.pl/uploads/tx\\_library/files/01\\_Wprowadzenie\\_do\\_zagadnien\\_edukacji\\_w\\_gospodarstwie\\_rolnym.pdf](http://ksow.pl/uploads/tx_library/files/01_Wprowadzenie_do_zagadnien_edukacji_w_gospodarstwie_rolnym.pdf), last accessed 2017/07/07.
7. Idziak, W. et al: Rural Tourism and Agritourism in the Financial Perspective 2014-2020, commissioned by the Ministry of Agriculture and Rural Development, Warsaw 2015.
8. Kacprzak, M.: Agroturystyka jako szansa rozwoju turystyki rodzinnej – przykład Małopolski. In: Iwan, B. (ed.) Kultura i przyroda w turystyce górskiej, Wyd. WSTiJO w Warszawie, Warszawa (2017).

9. Kacprzak, M., Król A., Wielewska, I.: Human Capital on the European Labour Market. In: Problems of World Agriculture, 17 (4), 143–150 (2017). DOI: 10.22630/PRS.2017.17.4.90.
10. Kryński, Z., Kusz, D., Augustyńska-Preisnar, A.: Motywy podejmowania działalności agroturystycznej. In: Turystyka wiejska a rozwój i współpraca regionów, Prace Naukowo-Dydaktyczne PWSZZ w Krośnie, Handbook #15, Krosno (2005).
11. Metelka, Ch. J.: The Dictionary of Hospitality, Travel and Tourism, Delmar Publishers Ins., Merton house travel and tourism published, Albany – New York, USA (1990).
12. Santucci, F. M.: Agritourism for Rural Development in Italy, Evolution, Situation and Perspectives, British Journal of Economics, Management & Trade, 3(3) (2013).
13. Sikora, J. (ed.): Turystyka wiejska a edukacja, różne poziomy, różne wymiary, Wydawnictwo Akademii Rolniczej im. Augusta Cieszkowskiego w Poznaniu, pp. 40-45, Poznań (2007).
14. Sznajder, M., Przezbórska, L.: Agroturystyka, PWE, Warszawa (2006).
15. Wielewska, I., Kacprzak, M., Król, A., Siedlecka, A.: Human Capital in the Aspect of Raising Innovativeness in Rural Areas. In: International Scientific Days 2018. "Towards Productive, Sustainable and Resilient Global Agriculture and Food Systems." Conference Proceedings, pp. 1810-1823, Nitra (2018).

## Comparison of Living Costs by Means of Monetary Minute Currency

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**Abstract.** The contribution follows a series of evaluation studies on design of the currency called “Monetary Minute Currency” (in abbreviation MMC or MonMin Currency), and its use for determination and comparison values of several products and commodities in the U.S., and several European markets, which were presented in the HED conferences in the past five years. In the current article, the living costs in Luxemburg, U.S.A., Czech Republic, Paraguay, Nigeria, the Republic of Congo, and Tanzania in 2016 were recalculated into MM\$ and re-normalized by the Average Monthly Disposable Salary (Expressed in Monetary Minutes) in each of the countries, respectively. Thus, the comparison of the consumption of the human lifetime (expressed in %) on the same items of food, beverages, household things, services, entertainment, and others in the above mentioned randomly selected countries could be done and discussed.

**Keywords:** Time, Economic Value, Time-Based Money, Monetary Minute Currency.

### 1 Introduction

The Economy is a wonderful discipline, which is of the utmost importance in all kinds of entrepreneurship, business, social activities of humankind, as well as in the everyday life of people [10-13]. However, Economy has a vexatious Achilles heel in a definition of the Value [2, 6, 8, 25]. The role of the Value for evaluation of economic entities and processes in applied economy, entrepreneurship, business, everyday human activities, etc. has been played by money for ages – in its various forms [9, 14, 16]. Values of all of them have been based on negotiation, bargaining, settlement, agreement, market situation, economic, and political power or position of the participants (individual merchants, firms, companies, countries, banks, etc.) [10].

The problem is even augmented by the fact, that modern money systems are prevalingly debt-based (enabling fractional reserve banking) instead of value-based [12, 14, 15]. Further, the amount of money in current economies - and consequently its value - is regulated subjectively by governments and central banks and/or by other monetary authorities on the basis of a declared monetary policy. These two aspects contribute/cause devastating financial crisis time to time [e.g. 1, 3-5, 15]. It is a matter

of fact, that the modern money is not tied to any “firm” or material background like gold, used to serve for many years in the past.

In my previous works [10, 12], I have postulated Time as a Commodity for establishment, measurement, and evaluating a value of economic entities and processes.

In the works [10-12], I have defined a new currency called a “TBM” (for Time-Based Money), as a value of the GDP per capita divided by the number of minutes per year (i.e. 525600) [10]. I have tested the TBM values in the U.S. and the Czech economies, and later on in the Slovak, Polish, and Hungary economies, for a span of 2011-2015 years, too [12, 13].

In the antecedent contributions [12, 13], I have focused on the comparison of the living costs and/or incomes evaluated in so-called Monetary Minute currencies (in abbreviation MMC), which were related to the currently used currencies (like in \$, €, £, and others) via the above mentioned TMB.

In the current article, I have focused on the comparison of consumption of the human lifetime (expressed in %) on the same items of food, beverages, household things, services, entertainment, and others in randomly selected countries - in Luxemburg, U.S.A., Czech Republic, Paraguay, Nigeria, the Republic of Congo, and Tanzania in 2016.

## **2 Methods Used**

This evaluation study is based on the method of qualitative analysis of secondary data and information available on the function of money. I used the data on GDP per capita 2016 related to the Luxemburg, the U.S.A., the Czech Republic, Paraguay, Nigeria, the Republic of Congo, and Tanzania in 2016 from the World Bank [24], and I used values of living costs and incomes in the relevant countries in the year 2016 from NUMBEO [17-23].

I calculated TB\$ values as ratios of the GDP per capita divided by the number of minutes per year (i.e. by 525600) [10] for the Luxemburg, the U.S.A., the Czech Republic, Paraguay, Nigeria, the Republic of Congo, and Tanzania in 2016 (the values of the TB\$ are presented in Table 1).

I divided the individual items of the living costs by the relevant TB\$ of each of the countries; thus, I obtained the living costs and incomes evaluated in MM\$ (see Table 2 and Figure 1).

I re-normalized the values by the Average Monthly Disposable Salary - Expressed in Monetary Minutes (MM\$) - in each of the countries in 2016, (see Table 3, and 4). In such way, I have received the values of the consumption of the human lifetime (expressed in %) on the same items of food, beverages, household belongings, services, entertainment, and others, in each of the countries in 2016, respectively.



### 3 Results

In Table 1, there are given values of the GDP per capita and the TB\$ in Luxemburg, in the U.S.A., in the Czech Republic, in Paraguay, in Nigeria, in the Republic of Congo, and in Tanzania in 2016.

The individual values of the GDP per capita, and consequently of the TB\$ in individual states differ considerably - more than 100 times between Luxemburg (102,831 US\$ p.c.) and Tanzania (879 US\$ p.c.) - in their GDP nominal values, and more than 200 times in TB\$ between Luxemburg (0.19587 US\$ per Minute) and Tanzania (0.00167 US\$ per Minute).

**Table 1.** Values of the GDP p.c. and the TB\$ in Luxemburg, the U.S.A., the Czech Republic, Paraguay, Nigeria, the Republic of Congo, and Tanzania in 2016 [24].

Rank	Country	GDP nominal p.c., in US\$	TBM in US\$/Minute
1.	Luxembourg	102.831	0.195869
7.	the U.S.A.	57.467	0.109461
35.	the Czech Republic	18.267	0.034794
99.	Paraguay	4.08	0.007771
128.	Nigeria	2.178	0.004149
135.	Republic of Congo	1.528	0.002910
152.	Tanzania	879	0.001674

In Table 2, there is given a list of several food staff costs and also salaries expressed in the Monetary Minutes (MM\$) values in the individual states. The values of individual items of the living costs expressed in MM\$ show large and confused disparities both, in expenditures, and salaries.

However, taking into account the level of allocated Average Monthly Disposable Salary (Net After Tax) expressed in MM\$, the overall picture changes considerably, as it is shown in following Tables 3, and 4.

In Table 3, there is given the same list of several food staffs prices as that in Table 2, this time expressed in percentage of the average monthly disposable salaries, in individual countries under the study in 2016.

**Table 2.** List of Several Food Staffs Prices and Average Monthly Disposable Salaries Expressed in the MM\$ Values in individual countries under study in 2016 [17-23], [24].

	Luxemburg	United States	Czech Rep.	Paraguay	Nigeria	Congo	Tanzania
	[Min]	[Min]	[Min]	[Min]	[Min]	[Min]	[Min]
<b>Restaurants</b>							
Meal, Inexpensive Rest.	105	119	159	515	335	2938	1864
Meal for 2 People, Mid-range Rest., Three-course	421	457	695	2405	4008	16546	15119
McMeal at McDonalds	52	64	159	619	1236	4296	3996
Domestic Beer(0.5draught)	30	37	40	126	200	632	800
Imported Beer (0.33 bottle)	24	46	53	218	335	1031	1195

Coke/Pepsi (0.33 bottle)	16	16	37	112	87	405	293
Water (0.33 liter bottle)	12	13	28	71	53	296	179
<b>Markets</b>							
Milk (regular), (1 liter)	7	8	23	127	374	777	657
Fresh White Bread (500g)	11	23	27	56	224	570	358
Rice (white), (1kg)	13	36	43	84	518	1292	627
Eggs (regular) (12)	19	23	47	143	398	907	1237
Local Cheese (1kg)	84	98	237	925	1562	0	4755
Chicken Breasts, (1kg)	65	78	184	529	805	1546	2885
Beef Round (1kg)	105	105	281	768	911	5625	2539
Apples (1kg)	13	39	36	227	651	1797	1756
Banana (1kg)	11	14	40	92	340	1103	514
Oranges (1kg)	16	36	44	80	424	1423	633
Tomato (1kg)	16	36	53	215	441	1079	538
Potato (1kg)	9	23	21	140	415	1031	460
Onion (1kg)	11	23	18	95	275	1031	526
Water (1.5 liter bottle)	5	16	17	78	108	419	412
Bottle of Wine (Mid-Range)	48	110	132	859	803	2777	4779
Domestic Beer (0.5 bottle)	8	19	20	123	200	564	741
Imported Beer (0.33 bottle)	9	25	35	257	393	1375	962
Pack of Cigarettes (Marlb.)	35	62	131	230	200	825	848
<b>Salaries And Financing</b>							
Average Monthly Net Salary (After Tax)	17944	29700	29936	43567	46534	156893	192354

**Table 3.** List of several food-staff prices expressed in percentage of the average monthly disposable salaries in individual countries under the study in 2016 [17-23], [24].

	Luxemburg	United States	Czech Rep.	Paraguay	Nigeria	Congo	Tanzania
	[%]	[%]	[%]	[%]	[%]	[%]	[Min]
<b>Restaurants</b>							
Meal, Inexpensive Rest.	0.58	0.40	0.53	1.18	0.72	1.87	1864
Meal for 2 People, Mid-range Rest., Three-course	2.35	1.54	2.32	5.52	8.61	10.55	15119
McMeal at McDonalds	0.29	0.22	0.53	1.42	2.66	2.74	3996
Domestic Beer (0.5 draught)	0.17	0.12	0.13	0.29	0.43	0.40	800
Imported Beer (0.33 bottle)	0.13	0.15	0.18	0.50	0.72	0.66	1195
Coke/Pepsi (0.33 bottle)	0.09	0.05	0.12	0.26	0.19	0.26	293
Water (0.33 liter bottle)	0.07	0.04	0.09	0.16	0.11	0.19	179

<b>Markets</b>							
Milk (regular), (1 liter)	0.04	0.03	0.08	0.29	0.80	0.50	657
Fresh White Bread (500g)	0.06	0.08	0.09	0.13	0.48	0.36	358
Rice (white), (1kg)	0.07	0.12	0.14	0.19	1.11	0.82	627
Eggs (regular) (12)	0.11	0.08	0.16	0.33	0.85	0.58	1237
Local Cheese (1kg)	0.47	0.33	0.79	2.12	3.36	0.00	4755
Chicken Breasts, (1kg)	0.36	0.26	0.61	1.21	1.73	0.99	2885
Beef Round (1kg)	0.59	0.35	0.94	1.76	1.96	3.59	2539
Apples (1kg)	0.07	0.13	0.12	0.52	1.40	1.15	1756
Banana (1kg)	0.06	0.05	0.13	0.21	0.73	0.70	514
Oranges (1kg)	0.09	0.12	0.15	0.18	0.91	0.91	633
Tomato (1kg)	0.09	0.12	0.18	0.49	0.95	0.69	538
Potato (1kg)	0.05	0.08	0.07	0.32	0.89	0.66	460
Onion (1kg)	0.06	0.08	0.06	0.22	0.59	0.66	526
Water (1.5 liter bottle)	0.03	0.05	0.06	0.18	0.23	0.27	412
Bottle of Wine (Mid-Range)	0.27	0.37	0.44	1.97	1.72	1.77	4779
Domestic Beer (0.5 bottle)	0.05	0.06	0.07	0.28	0.43	0.36	741
Imported Beer (0.33 bottle)	0.05	0.09	0.12	0.59	0.84	0.88	962
Pack of Cigarettes (Marlb.)	0.19	0.21	0.44	0.53	0.43	0.53	848

192354

It is obvious from the Table 3, that the relative prices (in % of the average monthly disposable salaries) of meals and drinks in restaurants, as well as the relative prices of meals and drinks in the corresponding markets were in the range of units of % (with exception of the three-course meal in restaurant in the Republic of Congo, which price was higher than 10%), while most of the items in Paraguay, Nigeria, the Republic of Congo and Tanzania were several times higher than in the United States, Luxembourg, and in the Czech Republic.

In Table 4, there is given the list of relative Transportation, Utilities, Sport and Leisure Child Care, Clothing and Shoes, Rental per Month, and Buy Apartment relative prices expressed in percentage of the average monthly disposable salaries in individual countries under the study in 2016.

**Table 4.** Relative Transportation, Utilities, Sport and Leisure, Child Care, Clothing and Shoes, Rental per Month, and Buy Apartment prices to a percentage of the average monthly disposable salaries in individual countries under the study in 2016 [17-23], [24].

	Luxemburg	United States	Czech Rep.	Paraguay	Nigeria	Congo	Tanzania
<b>Transportation</b>							
One-way Ticket	0.07	0.07	0.11	0.12	0.22	0.11	0.06
Monthly Pass	1.51	2.00	2.30	7.62	21.17	19.71	10.39
Taxi Start (Normal Tariff)	0.09	0.09	0.18	0.26	0.57	0.36	0.69
Taxi 1km (Normal Tariff)	0.10	0.05	0.11	0.53	0.28	0.35	0.42
Taxi 1hour Waiting	1.01	0.83	1.33	3.15	1.43	1.83	1.39
Gasoline (1 liter)	0.04	0.02	0.13	0.00	0.21	0.26	0.29
Volkswagen Golf1.4 90KW	704.23	673.65	1827.12	4230.48	4305.98	6570.88	8729.41
Toyota Corolla 1.6l 97kW	806.32	621.11	1901.41	6901.91	6688.62	4868.23	3133.34
<b>Utilities (Monthly)</b>							
Basic (Electricity, Heating, Cooling, Water, Garbage) for 85m2 Apartment	7.42	4.54	17.41	21.73	18.30	27.49	20.92
1 min. of Prepaid Mobile Tariff Local	0.00	0.00	0.01	0.04	0.05	0.03	0.04
Internet (60 Mbps or More, Unlimited Data, Cable/ADSL)	1.43	1.74	1.79	12.21	28.80	65.71	41.21
<b>Sports and Leisure</b>							
Fitness Club, Monthly Fee for 1 Adult	1.83	1.11	3.28	7.36	16.38	24.82	22.35
Tennis Court Rent (1 Hour on Weekend)	0.75	0.47	1.05	2.93	2.87	5.84	2.71
Cinema, , 1 Seat	0.30	0.34	0.71	1.84	2.15	3.50	1.40
<b>Childcare</b>							
Preschool/Kindergarten, Private, Monthly 1 Child	35.68	25.98	39.29	20.36	47.94	65.71	107.77
International Primary School, Yearly 1 Child	503.09	553.68	658.60	662.20	1498.48	0.00	0.00
<b>Clothing and Shoes</b>							
1 Pair of Jeans (Levis 501)	2.54	1.28	6.95	18.59	10.55	12.37	10.30
1 Summer Dress in a Chain Store (Zara, H&M, ...)	1.34	1.06	3.30	11.86	14.71	14.24	16.82
1 Pair of Nike Running Shoes (Mid-Range)	3.02	2.26	7.63	21.55	21.02	36.51	17.31
1 Pair of Men Leather Business Shoes	4.30	2.82	9.06	15.68	27.39	27.38	20.57
<b>Rental per Month</b>							
Apartment (1 bedroom) in City Centre	46.10	36.64	52.75	73.58	260.27	219.03	120.82
Apartment (1 bedroom) Outside of Centre	37.07	28.68	40.93	58.18	116.93	80.31	84.75
Apartment (3 bedrooms) in City Centre	89.21	58.76	87.30	159.79	511.18	763.09	358.13
Apartment (3 bedrooms) Outside of Centre	63.10	45.54	60.28	119.70	278.10	244.59	304.34
<b>Buy Apartment Price</b>							
Price per Square Meter to Buy Apartment in City Centre	260.28	69.39	297.11	223.35	478.44	1886.09	372.64

Price per Square Meter to Buy Apartment Outside of Centre	197.89	49.41	203.06	193.90	95.69	1314.18	355.15
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It can be deduced from the figures listed in the Table 4, that:

- the relative prices (in %) of Transportation, Utilities, and Sport and Leisure were relatively low - from zero to tenths percentage of the average monthly disposable salaries in all of the countries studied. Just relative prices for Monthly Pass, Basic Utilities, and Internet were somewhat higher in Paraguay, Nigeria, Republic of Congo and Tanzania than in the United States, and in Luxembourg.
- The relative prices of cars are many times greater than the average monthly disposable salaries expressed in MM\$ in individual countries under the study in 2016. The lowest relative prices were found in the U.S.A. (673.65 %, and 621.11 %, respectively for Volkswagen Golf, and for Toyota Corolla). The highest relative price of Volkswagen Golf – 8729.41 % - was found in Tanzania, and for Toyota Corolla – 6688.62 % in Nigeria, which seem to be very high to afford the cars by people with average incomes.
- The Pre-School Private 1 Child Care per Month were found as high as tens percent of the average monthly disposable salaries in most of the countries studied (in Tanzania it was nearly 108%), and they were somewhat higher in Nigeria, the Republic of Congo and Tanzania than in the United States, Luxembourg, the Czech Republic, and in Paraguay.
- The relative prices of the International Primary School for 1 Child per Year were found more than five (in Nigeria nearly fifteen) times higher than were the average monthly disposable salaries in the individual countries studied.
- The relative prices (in %) of the Clothing and Shoes were from units up to tens of a percentage of the average monthly disposable salaries in all of the countries studied. They were higher in Paraguay, Nigeria, the Republic of Congo and Tanzania than in the United States, Luxembourg, and in the Czech Republic,
- The relative prices (in %) of the of the Rental per Month were as high as tens (in the United States, Luxembourg, and in the Czech Republic) up to several hundred percent of the average monthly disposable salaries - Paraguay, Nigeria, Republic of Congo and Tanzania. It means, that people with average monthly incomes cannot afford to rent apartments in the Cities in those countries,
- The prices per Square Meter to Buy in the U.S.A. were only several ten percent, meanwhile the prices per Square Meter to Buy in Luxembourg, the Czech Republic, Paraguay, and Tanzania were comparable in hundreds of Percent.
- Very high relative prices per Square Meter to Buy were found in the Republic of Congo, reaching more than 1800 % per Square Meter to Buy of the average monthly disposable salaries, in this country under the study in 2016. It means, that people with average monthly incomes can hardly afford to buy apartments this country at all.

#### 4 Discussion and Conclusions

This evaluation study is a part of testing the idea of using Time as a prospective base/commodity for a new money system, which would be objective, predictable, dynamically evolving, and readily introduced in the economy, business and everyday life [10-13].

In my previous works, I defined and tested so called Monetary Minute Currencies (in abbreviation MMC), consequently to my former work [12], in which I defined so-called Time-Based Money (“TBM”) as a value of the GDP per capita divided by the number of minutes per year (i.e. 525600). The MMC were related to the currently utilized currencies (like in \$, €, £, and others) via the mentioned TMB.

In this study, I have randomly selected several countries from the “List of per capita nominal GDP for countries” of the World Bank [24] from different positions. Namely, Luxembourg which took the 1<sup>st</sup> position in the “List ..”, the U.S.A.- the 7<sup>th</sup> position, , the Czech Republic – 35<sup>th</sup> position, Paraguay – 99<sup>th</sup> position, Nigeria – 128<sup>th</sup> position, the Republic of Congo – 135<sup>th</sup> position, and Tanzania, which took a 152<sup>nd</sup> position in the World (see Table 1).

Then, I have calculated the TB\$ (in Minutes) for the individual countries (by dividing corresponding values of the GDP per capita with the number of minutes per year (i.e. 525600). As expected, the value of the TB\$ corresponding to the individual countries studied differed considerably (see Table 1).

In the second step, I divided values from the “Costs of Living” - published by the NUMBEO [17-23] for the countries under discussion - by corresponding values of the TB\$. Thus, I have received the List of Several Food Staffs Prices and Average Monthly Disposable Salaries Expressed in the MM\$ Values in individual countries under the study in 2016 (see Table 2). The values of individual items of the living costs expressed in MM\$ showed large, confused disparities both, in expenditures, and salaries.

That is why I divided the individual items of costs in Table 2 by corresponding values of the Average Monthly Disposable Salary (Net After Tax) expressed in MM\$. In this way, I received an overview of the costs/prices of living expressed in percentage of the average monthly disposable salaries, in individual countries under the study in 2016 (see Tables 3, and 4). In other words, I received the values of the consumption of the human lifetime (expressed in % of the average monthly disposable salaries) on the same items of food, beverages, household belongings, services, entertainment, and others, in the individual countries in 2016, respectively.

Surprisingly, the found prices of “standard level” food-staff and products expressed in a percentage of the average monthly disposable salaries, in individual countries under the study in 2016 did not differ so significantly as the “high level” products, goods and services, and housing (see Table 4).

They can reveal not just the differences in prices of selected food staffs and products, services, etc. but also the differences in affordability of the products taking into account the average monthly disposable salaries in different countries on the “homologized” Monetary Minute base.

The results of the current study show, that MM\$ can serve for comparison of values/costs/prices of the same/similar products or - generally - all economic entities expressed in different currencies, and to reveal disparities among them [10-13].

However, the whole picture, namely the affordability of the food-staff products, goods, services, etc. should be interpreted with caution – in relation with number of family member dependent on disposable salaries, unemployment rate, and the general social situation in specific countries.

The quantitative accuracy and reliability of the results given in the study are limited by the accuracy and reliability of the figures available and the time of its creation.

In the former work was found [12], that the current nominal value of a specific economic entity expressed in Monetary Minutes, i.e. MM\$, MM£, MME, etc. differs in relation on which current money currency system - USD, GBP, EUR, etc. - is used, respectively. From this point of view, the comparison would be better done on the base of GDP, p.c. expressed in corresponding currencies of individual countries studied. It is, not in the U.S. Dollars only, as the situation can be influenced by exchange ratios policies, and also by the access policies the international markets. However, there was found lack of reliable data on GDP, number of population, unemployment, currency ratio policies, etc. pertinent to individual countries.

Nevertheless, the quality of the fundamental finding, i.e.: the currency MonMin can serve as a useful and practical tool for the Value determination, and for measurement of any economic entities (either elements and/or processes) is undeniable.

Taking into account the results of this and my previous works [10-13], I dare state that the TBM and MMC are prospective tools for tracing, measuring, and analyzing wide spectrum of value transformations in the real economy, including production costs/efficiency diversities in different countries or regions, and different historical eras in a more objective way, than the current spectrum of currencies worldwide enable.

(Note: I do not insist on the only term/name/title “MMc” for the currency called “Monetary Minute Currency”. The abbreviations such as TMc (for the “Time Money Currency”) could be better for practical use especially, when relating to the specific traditionally used money (*like “Time Money Dollar” - TM\$ or “Time Dollar” - T\$, “Time Money Pond” - TM£ or “Time Pound” - T£, “Time Money EUR” - TME or “Time EUR” - T€, etc.*).

**Acknowledgements.** The author of the contribution is obliged to express deep thanks to Prof. Ing. Ladislav Hájek, CSc. from the Faculty of Informatics and Management of the University of Hradec Kralove for his valuable discussions and advice which considerably improved the quality of the contribution.

## References

1. Abel, A., Bernanke, B.: Fractional-reserve banking "14". In: Macroeconomics (5th ed.). Pearson. pp. 522–532. (2005).
2. Acemoglu, D.; Robinson, J. A.: Why Nations Fail: The Origins of Power, Prosperity, and Poverty. Crown Business division of Random House (2012).

3. Angelides Commission: Conclusion of the Financial Crisis Inquiry Commission, (2011), [http://web.archive.org/web/20110304020317/http://c0182732.cdn1.cloudfiles.rackspacecloud.com/fcic\\_final\\_report\\_conclusions.pdf](http://web.archive.org/web/20110304020317/http://c0182732.cdn1.cloudfiles.rackspacecloud.com/fcic_final_report_conclusions.pdf) , last accessed 2018/11/15.
4. Bernanke, B.S.: Four Questions about the Financial Crisis, Lecture at Morehouse College, Atlanta, Georgia, Board of Governors of the Federal Reserve System, 14. April, (2009), <http://www.federalreserve.gov/newsevents/speech/bernanke20090414a.htm>, last accessed 2018/11/15.
5. Classens, S. and Kose, M.A.: Financial Crises: Explanations, Types, and Implications, IMF Working Paper WP/13/28, International Monetary Fund (2013), <http://www.imf.org/external/pubs/ft/wp/2013/wp1328.pdf>., last accessed 2018/11/15.
6. Collom, E., Kyriacou, C., Lasker, J. Equal Time, Equal Value: Community Currencies and Time Banking in the US. Routledge, New York (2016).
7. D-Statistisches Bundesamt, 2016, [https://www.destatis.de/EN/FactsFigures/NationalEconomyEnvironment/NationalAccounts/DomesticProduct/Tables/Q\\_GDP.html](https://www.destatis.de/EN/FactsFigures/NationalEconomyEnvironment/NationalAccounts/DomesticProduct/Tables/Q_GDP.html), last accessed 2017/03/30.
8. George H., Davis, L.: Chapter 8 — Economic Value — Its Real Meaning and Final Measure. [http://www.politiceconomy.org/speII\\_8.htm](http://www.politiceconomy.org/speII_8.htm), last accessed 2017/03/30.
9. Friedman, M.: Money, Encyclopaedia Britannica, <https://www.britannica.com/topic/money>, last accessed 2017/06/27.
10. Kala, T.: Management & Financial and Economic Crisis 2007-2008, In: Jedlička, P. (ed.) Conference on Economic Development and Management of Regions, Hradec Economic Days (HED) 2014, Hradec Kralove 2014, Gaudeamus Hradec Kralove, pp. 415–421. (2014).
11. Kala, T.: Time-Based Money System: Its Use in the U.S.A. and the Czech Economies, 2016 Advancement on Informatics, Business and Management International Conference (ADIBUM), September 20 – 22, 2016, University of Hradec Kralove, Czech Republic, Journal of Engineering and Applied Sciences (Medwell Journals) Special Issue. ISSN 1816-949x (Print) ISSN 1818-7803 (in Print).
12. Kala, T.: Time-Based Money in V4 Economies, In: Jedlička, P., Soukal, I., Maresova, P. (eds.), Hradecké ekonomické dny Roč. 7(1) Recenzovaný sborník mezinárodní odborné konference Hradecké ekonomické dny 2017 Hradec Králové 31. ledna a 1. února 2017, Hradec Kralove, pp. 73–78. (2017).
13. Kala, T.: Monetary Minute Currency – An Economic Value Setting Tool, In: Jedlička, P., Soukal, I., Maresova, P. (eds.), Hradec Economic Days Vol. 8(1) Double-blind peer-reviewed proceedings part I. of the international scientific conference Hradec Economic Days 2018, pp. 377–387. (2018).
14. Kortsch, U.: Proposed Monetary Plan for the US. In Monetary Plan Overview, Monetary Trust Initiative, [https://wiki.p2pfoundation.net/Monetary\\_Trust\\_Initiative](https://wiki.p2pfoundation.net/Monetary_Trust_Initiative), last accessed 2017/06/28.
15. Mishkin, F.S.: The Economics of Money. In: Banking, and Financial Markets (Alternate Edition), Boston, Addison Wesley (2007).
16. Ng, S. and Wright, J.H.: Facts and Challenges from the Great Recession for Forecasting and Macroeconomic Modeling, Journal of Economic Literature 51(4), pp. 1120–1154. DOI: 10.1257/jel.51.4.1120.
17. NUMBEO: Costs of Living, [https://www.numbeo.com/cost-of-living/country\\_result.jsp?country=Luxembourg&displayCurrency=USD](https://www.numbeo.com/cost-of-living/country_result.jsp?country=Luxembourg&displayCurrency=USD), last accessed 2017/12/08.
18. NUMBEO: Costs of Living, [https://www.numbeo.com/cost-of-living/country\\_result.jsp?country=United+States](https://www.numbeo.com/cost-of-living/country_result.jsp?country=United+States), last accessed 2017/12/08.



19. NUMBEO: Costs of Living,  
[https://www.numbeo.com/cost-of-living/country\\_result.jsp?country=Czech+Republic&displayCurrency=USD](https://www.numbeo.com/cost-of-living/country_result.jsp?country=Czech+Republic&displayCurrency=USD), last accessed 2017/12/08.
20. NUMBEO: Costs of Living,  
[https://www.numbeo.com/cost-of-living/country\\_result.jsp?country=Paraguay](https://www.numbeo.com/cost-of-living/country_result.jsp?country=Paraguay), last accessed 2017/12/08.
21. NUMBEO: Costs of Living,  
[https://www.numbeo.com/cost-of-living/country\\_result.jsp?country=Nigeria&displayCurrency=USD](https://www.numbeo.com/cost-of-living/country_result.jsp?country=Nigeria&displayCurrency=USD), last accessed 2017/12/08.
22. NUMBEO: Costs of Living,
23. [https://www.numbeo.com/cost-of-living/country\\_result.jsp?country=Congo](https://www.numbeo.com/cost-of-living/country_result.jsp?country=Congo), last accessed 2017/12/08.
24. NUMBEO: Costs of Living,  
[https://www.numbeo.com/cost-of-living/country\\_result.jsp?country=Tanzania&displayCurrency=USD](https://www.numbeo.com/cost-of-living/country_result.jsp?country=Tanzania&displayCurrency=USD), last accessed 2017/12/08.
25. World Bank: International Comparison Program database,  
[http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?order=wbapi\\_data\\_value\\_2014+wbapi\\_data\\_value+wbapi\\_data\\_value-last&sort=desc](http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?order=wbapi_data_value_2014+wbapi_data_value+wbapi_data_value-last&sort=desc), last accessed 2017/12/04.
26. Wolff, R. D., Bruce B. Callari, R., Callari, A.: Marx's (not Ricardo's) 'Transformation Problem: A Radical Reconceptualization, History of Political Economy, 14(4): 564–582, (1982) DOI:10.1215/00182702-14-4-564.

## Regional Aid and its Importance in the Context of Total Public Aid in the European Union

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**Abstract.** The aim of the paper is to make analysis of regional aid volume allotted in the EU member states over the last years. The source analyses of the question have been performed looking into the Treaty on the European Union Functions, verdicts of the European Tribunal of Justice, and other acts of law and regulations which follow the Treaty. The analysis of the regional aid has been made with regard to the implementation of the conclusions of the 2020 Strategy and with the application of the Eurostat data. The paper supports the thesis that, according to the Treaty regulations and the Strategy Europe 2020 recommendations on public aid in the European Union member countries, the regional aid has currently a considerable share in the whole state aid for industries and services within the European Union.

**Keywords:** State Aid, Regional Aid, Structural Policy, Regional Development.

### 1 Introduction

Objectives and principles of regional aid are commonly known and successfully implemented in the European Union member countries. The principles lay legal ground for application of the aid, with much stress put on the issues appearing in less developed regions of Europe. The guidelines include methods for making maps of regional aid, where enterprises can be granted state aid with a proper level of intensity.

Major documents on the issue in the current financial perspective 2014-2020 are as follows:

- Communication from the Commission amending Annex I to the Guidelines on regional aid for 2014-2020 (Mid-term review of the regional aid maps) - Official Journal C231, 25.06.2016,
- Guidelines on regional State aid for 2014-2020. The new Guidelines have entered into force on 1 July 2014. Official Journal C209, 23.07.2013,
- Guidelines on regional State aid for 2014-2020: Acceptance of the proposed appropriate measures pursuant to Article 108(1) of the Treaty on the Functioning of the European Union by all Member States Official Journal C 101, 5.04.2014.

The issues related to the subject of state aid have been referred to many times on different occasions (vast material on numerous consultations is available on the websites of the European Commission). However, unveiling practical aspects and tendencies in the subject is still an interesting question. Empiric analysis and its conclusions also contribute into the existing literature on the issue. This paper refers to and presents the views presented in the material on state aid [see 1, 8, 11, 12, 14, 16], as well as it refers to the based – evidence policy [see 10, 13]. The conclusions presented in this paper can also be added to the existing literature on economic policies and their results [see 17, 18]. The content of the paper may also be considered as helpful at investment decisions made by companies [see 2, 9].

The paper attempts to make analysis of the volumes and ways of application of state aid at the regional level. The analysis has been performed with application of statistical methods and is based on the Eurostat data. The paper supports the thesis that state aid for regions has a considerable share in the total volume of state aid for industries and services in the EU, which is in line with the treaties referring to application of public aid in the EU.

## **2 Importance of Public Aid for Stimulating Economic Development**

Public aid is an instrument of the structural policy of the European Union. The structural policy comprises all measures and instruments in the domain of economy, law, management and other which express certain preferences and are important for economic entities at shaping and implementation of chosen structural goals. The overall objective is to increase economic effectiveness and boost growth. Another important aim is to cut down unemployment. That above can be reached through actions leading to economic modernization or development of innovative processes.

According to the liberal doctrine, the role of the state should be reduced to minimum and allocation of productive resources should be regulated by market forces. Nevertheless, liberal interventionism leaves space for state intervention for correcting market mechanisms. It happens predominantly in cases when the market mechanism does not ensure optimal allocation of resources.

The view supporting state interventionism has been more and more present in the last years, particularly at the end of the first decade of the XXI century, after the outbreak of the financial crisis and collapse of the financial markets in the aftermath of Lehman Brothers bankruptcy. Numerous financial institutions faced difficulties when trying to obtain funding necessary for further operations. The European Union, which normally follows strict rules on public aid application, at that time released aid packages aimed at battling the financial crisis. The aid featured some elements of analogy towards classical approach which stresses that stabilisation of the economic cycle can be successfully influenced by state interventions, active economic policies of the central government, thus changing the cycle through public spending (the theory of J.M. Keynes). However, some aspects of the 2008 crisis handling showed that the modern

public interventionism is characterised by a different level of legal regulations and controlling powers.

Currently, restrictive European regulations stress that public aid coming from member states or from public sources, which distorts or threatens to distort competition through privileges given to some companies, or /and is applied at production of certain goods, should be banned by definition, when such aid influences negatively commercial relations between member states. However, particular socio-economic conditions leave space for many exceptions. Justifiable public aid includes measures aimed at job creation, improvement of regional competitiveness or supporting innovative solutions, as well as at the ventures related to research and development. Public aid must, at the same time, meet certain requirements, i.a.:

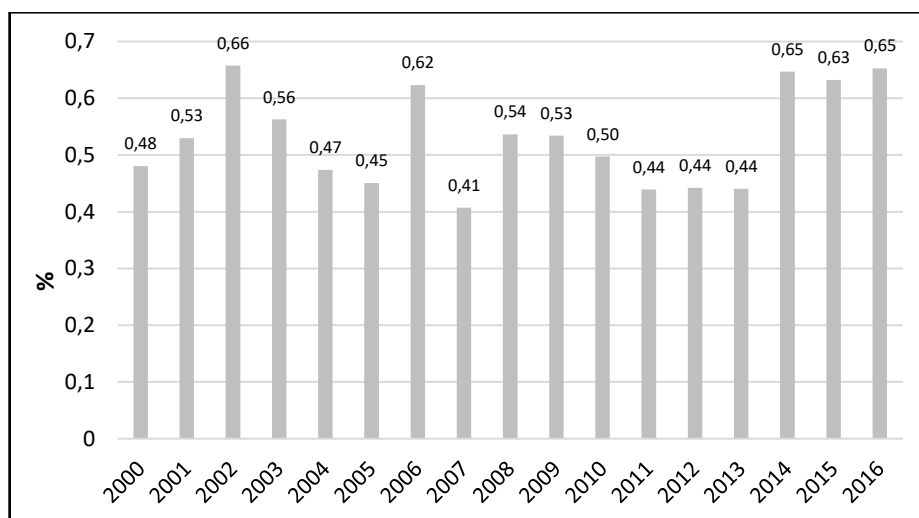
- be applied to a company (or an entrepreneur), as defined by the EU laws on competition,
- be granted by the state or from public financial means,
- be allotted upon more favourable conditions than the ones offered by the market,
- have a selective character for certain company or companies, or production of certain goods,
- not threaten to distort or distort competition and have influence on trade between the European Union member states.

Public aid, i.a., subsidies, preferential loans or tax exemptions are instruments of state interventionist policies. Consequences of pursuing such economic policies can be meaningful and public aid is an adequate tool for stimulating economic development. However, incompetent usage of public aid instruments can lead to market distortions. Having in mind the above, it is crucial to apply aid whose consequences are positive and lead to achieving goals set for economic policies of the countries which use such tools.

### **3 Tendencies in Allotting Public Aid in the European Union Countries**

Support given within public aid framework has crucial importance for development of European economies, especially when it contributes positively into easing economic and social tensions. It is widely admitted that state obligations include active forms of support for businesses, although the scale and methods of such support should be determined by particular scenarios which need to be constantly monitored.

When analyzing information which characterizes public aid (called here as state aid – the term used in the European statistics) over the last years (the “total state aid expenditure”), it needs to be concluded that its overall value has been increasing (see Fig. 1). The biggest amount of aid allotted to enterprises appeared in 2016 (97,298.8 mln EUR, which was 0.7 % of the GDP). In 2016 state aid spending increased in comparison with the 2015 level, both in numbers and in the percentage of the GDP. The percentage increase of state aid for all European Union countries in 2016 was 2.6 percentage points when compared with 2015 numbers (without inflation adjustment).

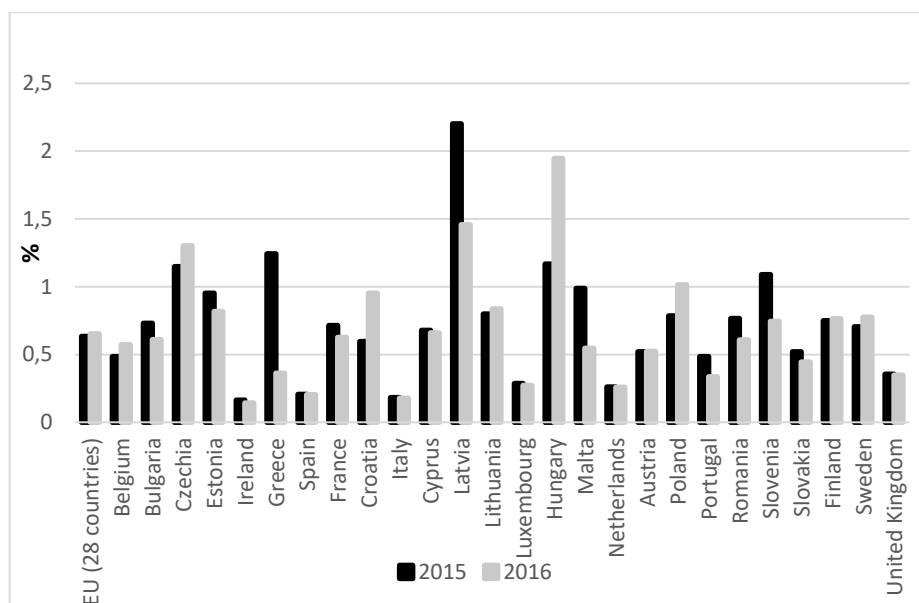


**Fig. 1.** State aid in 2016 in European Union (as % GDP) [15].

Analysis of changes in overall state support shows considerable disproportions among the EU member states (see graph 2). The biggest increase of state aid appeared in Hungary (+ 0.8 p.p. of GDP), Croatia (+ 0.3 p.p. of GDP), Poland (+ 0.2 p.p. of GDP) and the Czech Republic (+ 0.2 p.p. of GDP). In contrast, a considerable decrease of public aid was observed in Greece (- 0.9 p.p. of GDP), Latvia (- 0.7 p.p. of GDP), Malta (- 0.4 p.p. of GDP), Slovenia (- 0.3 p.p. of GDP) and Romania (-0.2 p.p. of GDP).

The changes in the level of state support have followed particular objectives chosen for cohesion policies. It results, in the first place, from reorientation of the European Union policies following the new goals set for the current financial perspective 2014 - 2020 and from implementation of the 2020 strategy being the main document related to the programmes of socio-economic development.

The main reason for increasing state aid in the European Union since 2014 have been larger expenditure on implementation of natural environment protection projects including energy saving. The expenditure is in line with the growing financial input into new projects supporting renewable energy sources in the countries such as Germany, the Czech Republic, Denmark and the United Kingdom.



**Fig. 2.** Total state aid in 2015 and 2016 (as % GDP) [15].

Another reason for increasing amount of public aid within the European Union over the last years has been implementation of projects for the common European interest and for local infrastructure including broadband Internet networks. The increase also covers new projects concerning various goals and tools, from the systems based on local income taxes, up to cross sectoral corporations, being implemented mainly in Belgium, Germany, Hungary and Italy.

Another important reason for more state support in the European Union is bigger expenditure on research, development and innovations. It mainly concerns countries like Italy, Hungary and Poland. Having in mind the contexts of strong global competition and the principles or regulations concerning public aid, they all seem to be flexible enough to justify even a high level of aid allotted in the case of projects requiring support for research, development and innovation.

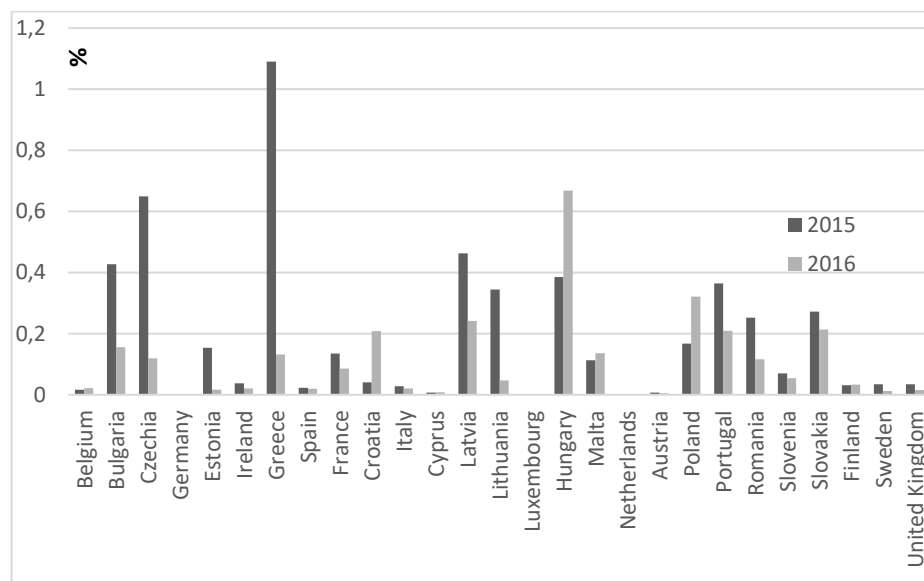
#### **4 Current Conditions and Tendencies in Authorization of Public Financial Support within Regional Aid Policies**

Regional aid is aimed at developing the regions featuring low standard of living and high unemployment and it offers support for projects of pan-European importance, as well as it prevents distortions in member states economies and helps to develop small and middle-size businesses. Regional aid can also enhance natural environment protection ventures supporting research and development, which is described as horizontal aid - the form directed at companies representing particular branches of

economy, and last but not least, it aims at supporting culture heritage of the European Union countries.

Generally speaking, the aid from those countries, accorded under strict conditions, can be divided into three categories, i.e.: regional aid, sectoral aid, and aid for sensitive sectors. Regional aid differs from other forms of horizontal aid by its geographical specifics. The general rule applied by the European Commission in the question of according original aid is determining analytical criteria which show that the overall area of the regions getting the aid must be smaller than three area which do not receive such support.

Regional aid can only play an effective role if it is used sparingly and proportionately and is concentrated on the most disadvantaged regions of the European Union. In particular, the permissible aid ceilings should reflect the relative seriousness of the problems affecting the development of the regions concerned. Furthermore, the advantages of the aid for the development of a less-favoured region must outweigh the resulting distortions of competition. The weight given to the positive effects of the aid is likely to vary according to the applied derogation of Article 107(3) of the Treaty [Official Journal of the European Union C 209/1, 23.7.2013, Art 5].



**Fig. 3.** Overall change in State aid for regional development between 2015 and 2016 in European Union (as % of GDP) [15].

A general analysis of the regional aid in the European Union shows that its volume and character do not feature stable or similar tendencies for all European Union member countries. The total amount of financial support within the regional aid framework decreased in 2016 when compared with 2015 and the reason for this might be connected with re-directing of the European Union aid towards the natural environment protection targets. However, in some selected countries the regional aid has gained importance

over this period. The countries above include Germany (+ 241 mln EUR), Hungary (334 mln EUR), and Poland (+ 652 mln EUR). The drop in the regional aid has amounted to 4 bln Euros and has been observed in Greece (- 1,7 bln EUR), France (- 1,1 bln EUR), the Czech Republic (-882 mln EUR), the United Kingdom (-544 mln EUR) and Portugal 9-267 mln EUR). In case of Greece, the decrease was due to re-classification of the Greek government loan guarantees and taking them away from the area of services for the common economic interest. In case of France, the drop results from lacking the proper registration in 2016 regarding particular tax exemptions for fees paid by employers in the most remote regions. Other changes result, to a large extent, from a transition between means accommodated in accordance with previous legal regulations and with the new guidelines for the regional aid 2014-2020, or they appear due to changes in the socio-economic situation of the regions (the weakest regions have changed strongly).

A good example of growing importance of the regional aid is Poland. The total amount of the aid allotted in 2016 was 1369,7 mln EUR, compared with only 651,7 mln EUR in 2015, showing a hike of 651,7 mln EUR. In 2016, the most of financial support was granted by tax authorities as income tax reductions for entities which run their business in special economic zones, allotted within the existing aid programmes or within complementary programmes. It can be noticed that the aid enhancing passive support (whose consequences cut down budget revenues) comes in line with the active form, which means support through state expenditure. In this case, the most common form of support are subsidies and other irreclaimable financial transfers through state agencies or the Bank for the National Economy (the BGK, in Poland).

## 5 Conclusions

State aid, well planned and constructed, is aimed at reducing market disturbances and at implementation of public interest goals. It can also contribute into economic growth and improve market reliability. State aid can be an effective tool in achieving goals for economic policies.

Regional aid has been widely applied in the European Union. In the previous financial perspective (2007-2013), regional aid amounted to 45 % of the total volume of public aid in some European Countries, e.g. in Poland. In the current financial perspective, the share of regional aid in total amount of state support, has increased by almost 10% (the example of Poland). When comparing various tendencies, it should be concluded that the sectoral aid volume has decreased in the same time from 19.9 % to 10.3 %, in relation to the total value of public aid.

In the current financial perspective (2014-2020), in many European countries, importance of regional aid has declined in favour of other kinds of public support. A majority of 16 member states - Germany, Sweden, Estonia, Romania, Austria, Finland, the Czech Republic, Bulgaria, Luxembourg, Denmark, Netherlands, Cyprus, Slovenia, Ireland and Croatia have spent public aid mostly for environment protection and energy saving. Research, development and innovation have been prime objectives in Belgium



and Italy, whereas culture has been the main aim in Lithuania and Latvia. Regional aid dominance has been typical for Poland, Hungary and Greece.

It can be concluded that a decrease of aid level for better developed regions will have a negative impact on support for large enterprises (where maximum level of aid threshold cannot be hiked). Such enterprises will then search other sources of public support. On the other hand, a high threshold of aid intensity is going to remain in the least developed regions (for example those located in the eastern part of Poland).

## References

1. Ambroziak, A.: Prawne i ekonomiczne aspekty pomocy regionalnej w Polsce po akcesji do UE, *Journal: Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*, Issue Year: 2015 Issue No: 380, Page Range: 177-188 [Legal and economic aspects of regional state aid in Poland after the accession to the EU] (2015),
2. Devereux, M. P., Griffith, R., Simpson, H.: Firm location decisions, regional grants and agglomeration externalities. *Journal of Public Economics*, 91(3-4), 413–435, (2007),
3. European Commission: Communication from the Commission amending Annex I to the Guidelines on regional aid for 2014-2020 (Mid-term review of the regional aid maps) - Official Journal C231, 25.06.2016,
4. European Commission: Guidelines on regional State aid for 2014-2020. The new Guidelines have entered into force on 1 July 2014. Official Journal C209, 23.07.2013,
5. European Commission: Guidelines on regional State aid for 2014-2020. The new Guidelines have entered into force on 1 July 2014. Official Journal C209, 23.07.2013,
6. European Commission: Guidelines on regional State aid for 2014-2020: Acceptance of the proposed appropriate measures pursuant to Article 108(1) of the Treaty on the Functioning of the European Union by all Member States Official Journal C 101, 5.04.2014,
7. Eurostat database. <http://ec.europa.eu/eurostat/data/database>, URL, last accessed 2018/09/30,
8. Harris, R., Robinson, C.: Impact of Regional Selective Assistance on sources of productivity growth: Plant-level evidence from UK manufacturing, 1990-98. *Regional Studies*, 39(6), 751–765, (2005),
9. Jones, J., Wren, C.: Do inward investors achieve their job targets. *Oxford Bulletin of Economics and Statistics*, 66(4), 483–513, (2004),
10. Kline, P.: Place based policies, heterogeneity, and agglomeration. *American Economic Review*, 100(2), 383–387, (2010)
11. Korbutowicz, T.: Regionalna pomoc publiczna w UE od 2014 roku, *Horyzonty Polityki*, 2017 | 8 | 23 | 219-238, DOI 10.17399/HP.2017.0823011, Regional state aid in the EU since 2014, (2017),
12. Moffat, J.: Regional Selective Assistance (RSA) in Scotland: Does It Make a Difference to Plant Survival? *Regional Studies*, 49(4), 568–581, (2015),
13. Neumark, D., Simpson, H.: Place-Based Policies. In G. Duranton & W. C. Strange (Eds.), *Handbook of Urban and Regional Economics*, volume 5 chapter 18, pp. 1197 – 1287, Elsevier, (2015),
14. Podsiadło, P.: Pomoc regionalna jako przykład dopuszczalnej warunkowo pomocy publicznej w Unii Europejskiej, *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu* 2014 | nr 348 Polityka ekonomiczna | 297-308, Regional Aid as an Example of Permitted Conditionally State Aid in the European Union, (2014),

15. State Aid Scoreboard 2017, European Commission [http://ec.europa.eu/competition/state\\_aid/scoreboard/index\\_en.html](http://ec.europa.eu/competition/state_aid/scoreboard/index_en.html). last accessed 2018/09/30,
16. Sztando, A.: Budżetowanie kapitałowe pomocy regionalnej w polskich specjalnych strefach ekonomicznych, Contents Journal: Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu, Issue Year: 2016, Issue No: 432, Page Range: 173-202, Capital budgeting of regional aid in Polish special economic zones (2016),
17. Wishlade, F.: The 1998 Guidelines: The Start of a New Era? In Regional State Aid and Competition Policy in the European Union chapter 4, pp. 87–118. Kluwer Law International, (2003),
18. Zimmer, H.: Labour market mismatches. Economic Review, XXXVIII(2), 55–68, (2012).

## **Market Activities in the Area of Product. A Comparison of Dairy Cooperatives from Świętokrzyskie and Małopolskie Voivodeships**

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**Abstract.** The purpose of this paper is an analysis of activities affecting the value for customers implemented by cooperatives producing dairy products from the Świętokrzyskie and Małopolskie Voivodeships from Poland on different markets in the sphere of product. Executives were asked during the direct interview to indicate activities that according to their opinion are affecting the value for customers on home voivodeship market, UE markets, other voivodeships' markets, and other main markets. They had to indicate if they offer organic products, products with high nutritional value, natural products, products with health properties, products in attractively designed packages, products in convenient packages, or products in packages that are pattern-matched to others. They could indicate as many activities as they implement. The analysis of conducted research shows that market activities in the area of product are in different extent implemented by cooperatives producing dairy products from the Świętokrzyskie and Małopolskie Voivodeships. The research results also show that cooperatives from both voivodeships do not implement any activity on EU market.

**Keywords:** Market Activities, Product, Cooperatives.

### **1 Introduction**

Companies need to know where their business sector is going, as well as understand their customers to remain at the forefront of competition, often to work with them in terms of future planning and rapid implementation [16]. It is very important, because how customers perceive the products or services of the organization compared to what they have heard or seen about other companies or organizations, and in the light of their experience with this organization (or product) determines customer satisfaction [15]. The markets are composed of consumers with different tastes, incomes, cultures, beliefs, expectations, norms and motives. These differences also affect the values owned and will be gained [16]. Moreover, the requirements of customers expecting constantly increasing quality and services at lower costs are becoming more and more visible [14]. To understand how customers define value, the company must focus on the outcomes that customers want when they buy and use company's products [13].

Therefore, marketing managers involved in the development of a business strategy should take these details into account [16].

The purpose of the paper is an analysis of activities affecting the value for customers implemented by cooperatives producing dairy products from the Świętokrzyskie Voivodeship and Małopolskie Voivodeship from Poland on different markets in the sphere of the product. The activities within the framework of product included: offering organic products, offering products with high nutritional value, offering natural products, offering products with health properties, offering products in attractively designed packages, offering products in packages that are pattern-matched to others, and offering products in convenient packages.

## **2 A Characteristic of Product**

The general purpose of any company is determining and satisfying the needs of customers using products that are available and have certain value, and whose features are clearly defined [3]. In essence, to anything offered by a firm to provide customer satisfaction refers the term “product”. It can be a single product, a combination of products, a product-service combination, or several related products and services [3]. We can distinguish three forms of products that are in consonance with the marketing concept which guides a marketer to offer a product that fulfills the needs and wants of the target market [7]: 1. the core product (the real core benefit or service), 2. the embodied product (the physical good or delivered service that provides the expected benefit), and 3. the augmented product (embodied product plus all those other factors that are necessary to support the purchase and any post-purchase activities) [1]. The product also has the societal aspect. That is, the product offered by a company is expected to be not only user-friendly (the one who owns and consumes the product) but also eco-friendly (the consumption of the product should not cause environmental degradation) [7]. To enhance a company’s current idea generation methods and vastly improve its development pipeline can a method that focuses on the product – What is essential? What can be removed, rearranged, or replicated in new ways? [5]. When customers buy products they are just not buying the simple functional aspect a product offers, there are other complexities involved in the purchase [1]. E. Miracle indicated certain product characteristics. These are:

- Unit value;
- Significance of each individual purchase to the consumer;
- Time and effort spent purchasing by consumers;
- Rate of technological change (including, fashion changes);
- Technical complexity;
- Consumer need for service (before, during, or after the sale);
- Frequency of purchase;
- Rapidity of consumption;
- Extent of usage (number and variety of consumers and variety of ways in which the product provides utility) [12].

From the consumer's viewpoint, a product is a bundle of benefits; some of those benefits are essential requirements, others are less important but still good to have, still others are not really relevant [2]. The benefits that the consumers want from the product can be divided into four types – basic product benefits, use benefits, package benefits, psychological benefits (table 1). According to Hokanson, factors that affect customer satisfaction include courteous employees, friendly employees, helpful employees, knowledgeable employees, billing timeliness, accuracy of billing, competitive pricing, good value, billing clarity, service quality and quick service [6].

**Table 1.** The benefits that the consumers want from the product [4].

Benefits	Items
Basic product benefits	physical characteristics (such as size, shape, color), sensory qualities, chemical composition, safety features and nutritional value.
Use benefits	information on use, convenience in buying and carrying, attractive presentation, easy preparation, recipes and nutritional information.
Package benefits	ease of storage, value for money, price, use and disposal.
Psychological benefits	fun and friendliness, prestige, healthiness, aesthetics.

### 3 Activities Affecting the Value for Customers in the Area of the Product – Research Results

Research on activities affecting the value for customers in the area of the product was conducted in cooperatives producing dairy products from the Świętokrzyskie and Małopolskie Voivodeships, which had given their consent. The research tool was an interview questionnaire. The questionnaire was sent to all cooperatives that produce dairy products from the Świętokrzyskie Voivodeship and Małopolskie Voivodeship. Due to the willingness of representatives of cooperatives to participate in the research, interviews were carried out on a sample of 41% of cooperatives producing dairy products from both voivodeships. Executives were asked to indicate activities affecting the value for customers on such markets as home voivodeship, other voivodeships, UE markets, and other main markets. The results of the interviews are presented in Tab. 2, Fig. 1 and Fig. 2.

When analyzing Table 2 and Figure 1 it is seen that:

- On the home voivodeship market one-third of cooperatives from Świętokrzyskie Voivodeship and one quarter of cooperatives from Małopolskie Voivodeship are offering organic products, products with health properties, and products in attractively designed packages. In the same time one-third of cooperatives from Świętokrzyskie Voivodeship and half of cooperatives from Małopolskie Voivodeship are offering natural products and products in packages that are pattern-matched to others. Moreover, 55% of cooperatives from Małopolskie Voivodeship are offering products with high nutritional value, while cooperatives from Świętokrzyskie Voivodeship do not implement such activity. Cooperatives from

Świętokrzyskie Voivodeship either do not offer products in convenient packages, whereas one quarter of cooperatives from Małopolskie Voivodeship do.

**Table 2.** Activities affecting the value for customers implemented by cooperatives producing dairy products from the Świętokrzyskie and Małopolskie Voivodeships on individual markets in the sphere of the product.

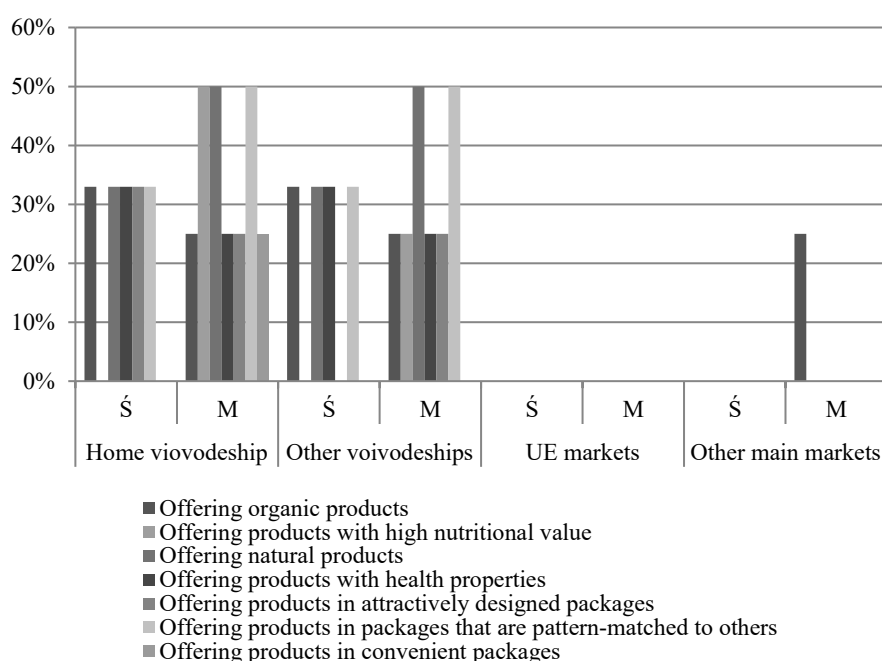
Activity	Home voivodeship*		Other voivodeships*		UE markets*		Other main markets*	
	Ś**	M***	Ś**	M***	Ś**	M***	Ś**	M***
Offering organic products	33%	25%	33%	25%	0%	0%	0%	25%
Offering products with high nutritional value	0%	50%	0%	25%	0%	0%	0%	0%
Offering natural products	33%	50%	33%	50%	0%	0%	0%	0%
Offering products with health properties	33%	25%	33%	25%	0%	0%	0%	0%
Offering products in attractively designed packages	33%	25%	0%	25%	0%	0%	0%	0%
Offering products in packages that are pattern-matched to others	33%	50%	33%	50%	0%	0%	0%	0%
Offering products in convenient packages	0%	25%	0%	0%	0%	0%	0%	0%

\* Multiply answers

\*\* Świętokrzyskie Voivodeship

\*\*\* Małopolskie Voivodeship

- On other voivodeships markets one-third of cooperatives from Świętokrzyskie Voivodeship and one quarter of cooperatives from Małopolskie Voivodeship are offering organic products and products with health properties. In the same time one-third of cooperatives from Świętokrzyskie Voivodeship and half of cooperatives from Małopolskie Voivodeship are offering natural products and products in packages that are pattern-matched to others. Furthermore, 55% of cooperatives from Małopolskie Voivodeship are offering products with high nutritional value, and products in attractively designed packages, whereas cooperatives from Świętokrzyskie Voivodeship do not implement these activities. Cooperatives from both voivodeships do not offer products in convenient packages on these markets.
- On EU markets cooperatives from both voivodeships do not implement any activity affecting the value for customers in the area of the product.
- On other main markets only 25% of cooperatives from Małopolskie Voivodeship offer organic products. Both cooperatives from Świętokrzyskie i Małopolskie Voivodeships do not implemented other activities.



Ś - Świętokrzyskie Voivodeship  
M - Małopolskie Voivodeship

**Fig. 1.** Chart for data from table 1.

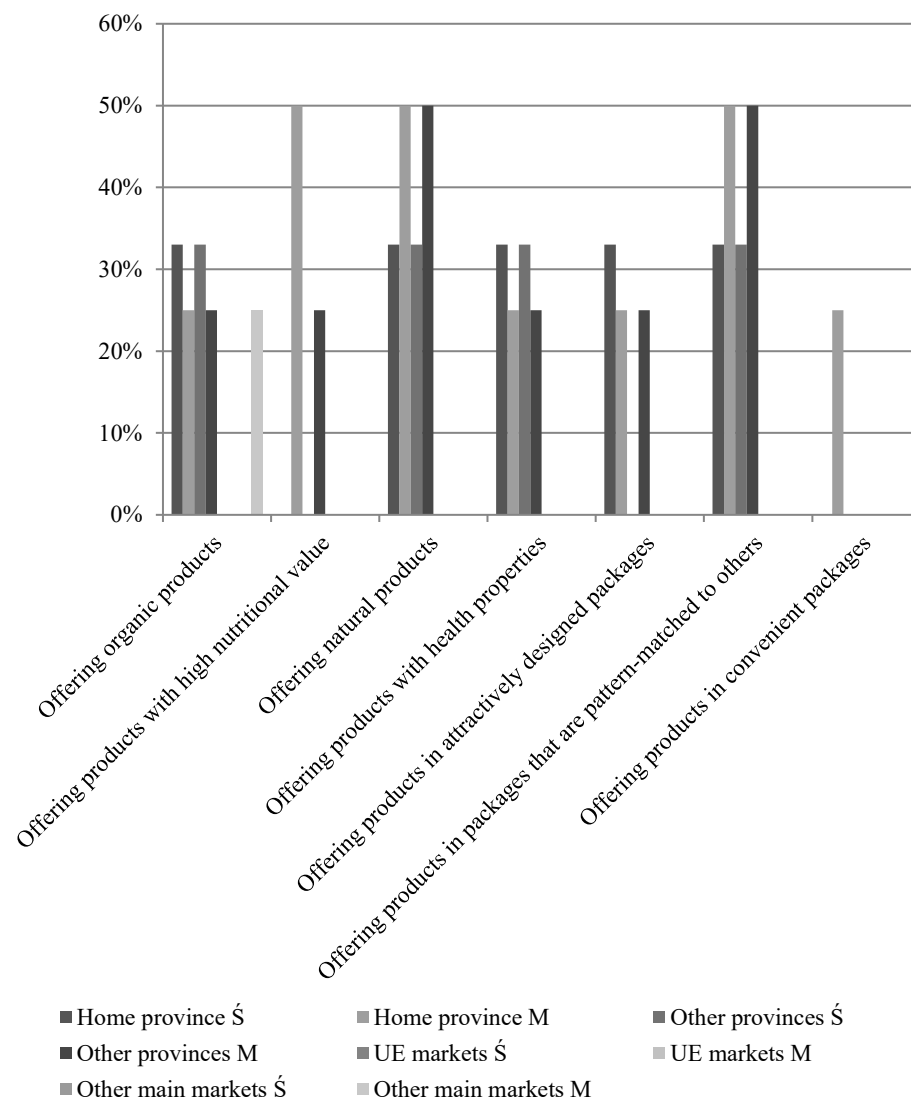
An analysis of Table 2 and Figure 2 shows that:

- Organic products offer 33% of cooperatives from Świętokrzyskie Voivodeship and one quarter of cooperatives from Małopolskie Voivodeship on the home market and

on other voivodeships markets. Moreover, one quarter of cooperatives from Małopolskie Voivodeship offer such products on other main markets, while cooperatives from Świętokrzyskie Voivodeship do not offer this kind of products on this market. Organic products are not offered on EU markets.

- Products with high nutritional value are only offered by cooperatives from Małopolskie Voivodeship on the home market (50%), and on other voivodeships markets (25%). Cooperatives from Świętokrzyskie Voivodeship do not offer such products.
- Natural products offer one-third of cooperatives from Świętokrzyskie Voivodeship and 50% of cooperatives from Małopolskie Voivodeship on the home market and on other voivodeships markets. On the EU market and on other main markets this kind of products are not offered.
- Products with health properties are offered by one-third of cooperatives from Świętokrzyskie Voivodeship and by 25% of cooperatives from Małopolskie Voivodeship on the home market and on other voivodeships markets. On the EU market and on other main markets is not offered this kind of products.
- Products in attractively designed packages offer one-third of cooperatives from Świętokrzyskie Voivodeship on the home market. On other indicated markets cooperatives from Świętokrzyskie Voivodeship do not offer such products. In the same time products in attractively designed packages are offered by one quarter of cooperatives from Małopolskie Voivodeship on the home market and on other voivodeships markets, while on other indicated markets they are not offered.
- Products in packages that are pattern-matched to others are offered by one-third of cooperatives from Świętokrzyskie Voivodeship and 50% of cooperatives from Małopolskie Voivodeship on the home market and on other voivodeships markets. On other main markets and on the EU market this kind of products is not offered.
- Products in convenient packages offer one quarter of cooperatives from Małopolskie Voivodeship on the home market. On other indicated markets they do not offer such products. In the same time cooperatives from Świętokrzyskie Voivodeship do not offer products in convenient packages at all.





Ś - Świętokrzyskie Voivodeship  
M - Małopolskie Voivodeship

Fig. 2. Chart for data from table 1.

## 4 Discussion

I. Konieczna analyzed the assessment of cooperatives producing dairy products from the Świętokrzyskie and Małopolskie Voivodeships of the validity of the features of the offer for customers in the area of the product. Cooperatives' executives indicated

features of the offer, which according to them are valid, for such customers as wholesalers, consumers, independent retail grocery stores, intermediary agents in food trade, companies - users (gastronomy), local retail chains, large retail chains, other institutional purchasers, and other dairies. The results of the research show that cooperatives from Świętokrzyskie and Małopolskie Voivodeships rather differently assess the validity of the offer features for customers in the sphere of the product [11]. In another article I. Konieczna and P. Garasym showed the perception of future managers, Polish and Ukrainian about products offered by cooperatives. Respondents stated that the cooperatives offer products in the average extend in all indicated fields, i.e. innovation, ecology, quality, and package [9]. I. Konieczna in another article conducted an analysis of the features of the offer that are for customers important and have an influence on customers' value in the sphere of sales marketing, in the opinion of managers of cooperatives producing dairy products from Świętokrzyskie Voivodeship. As research results show for each type of customers are different features extremely important, i.e. the price of the product for wholesalers, the range of pre-, peri-, and after-sales services for local retail chains, the payment terms for consumers, and promotional prices, the price of pre-, peri-, and after-sales services, and the crediting of purchases for companies-users (gastronomy) [8].

## **5 Conclusion**

Considering the results of research, it can be seen that, although activities connected with product affect the value for the customer, none of them is implemented by all cooperatives. What is seen that the focus and target of cooperatives from both voivodeships is put only on Polish market, because activities are implemented mostly on home voivodeship market and other voivodeships' markets. Only 25% of cooperatives from Małopolskie Voivodeship offer organic products on the other main markets. Besides, some activities are not implemented by cooperatives producing dairy products from Świętokrzyskie Voivodeship on the home voivodeship market and on other voivodeships' markets, while only one activity is not implemented on other voivodeships markets by cooperatives from Małopolskie Voivodeship. It is also seen that half of cooperatives producing dairy products from Małopolskie Voivodeship on both home market and on other voivodeships' markets implement such activities as offering natural products and offering products in packages that are pattern-matched to others. Increasing competition is likely to cause cooperatives in order to survive and develop the expansion of their activities to other markets. Furthermore, especially cooperatives from Świętokrzyskie Voivodeship that implement less activities than cooperatives from Małopolskie Voivodeship to be more competitive with high probability will have to expand the scope of activities in this area.

## References

1. Balnes, P., Fill, C., Page, K.: Marketing. 2nd edn. Oxford University Press, Oxford (2011).
2. Blythe, J.: Essentials of Marketing. 3rd edn. Prentice Hall, Harlow (2005).
3. Burnett, J.: Core Concepts of Marketing. 1st edn. Global Text Project, Zurich (2008).
4. Earle, M.D., Earle, R.L.: Creating New Foods. The Product Developer's Guide. 1st edn. Chadwick House Group Ltd, London (2000).
5. Goldenberg, J., Horowitz, R., Levav, A., Mazursky, D.: Finding your Innovation Sweet Spot. *Harvard Business Review*, 81(3), 120–129 (2003).
6. Hokanson, S.: The Deeper You Analyse, The More You Satisfy Customers. *Marketing News*, 29(1), 16 (1995).
7. Jayachandran, S.: Marketing Management. Text and cases. 1st edn. Excel Books, New Delhi (2006).
8. Konieczna I. The Validity of the Features of the Offer for Clients in the Sphere of Sales Marketing – the Assessment of Dairy Cooperatives from Świętokrzyskie Province. In: Primorac, Z., Bussoli, C., Recker, N. (eds.) *Economic and Social Development (Book of Proceedings)*, 16th International Scientific Conference on Economic and Social Development – Legal Challenges of Modern World, pp. 817–826, Varazdin Development and Entrepreneurship Agency, University of Split, University North, Split, (2016).
9. Konieczna, I., Garasym, P.: Perception of the Products Offered by Cooperatives in Poland and Ukraine. In: Hittmar, S. (ed.) *Theory of Management* 7, pp. 139–145, University of Žilina, Žilina (2014).
10. Konieczna, I.: Działania rynkowe w obszarze produktu na przykładzie spółdzielni mleczarskich z województwa świętokrzyskiego. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu – Strategie. Procesy i praktyki* 420, pp. 153–162 (2016).
11. Konieczna, I.: The validity of the features of the offer for customers in the area of the product. The comparison of the assessment of dairy cooperatives from the Świętokrzyskie and Małopolskie Provinces. In: Jedlička, P., Marešová, P., Soukal, I. (eds.) *Double-blind peer-reviewed proceedings of the international scientific conference Hradec Economic Days 2018*, pp. 417–427, University of Hradec Kralove, Hradec Kralove (2018).
12. Miracle, G.E.: Product Characteristics and Marketing Strategy. *Journal of Marketing*, 29, 18–24 (1965).
13. Sawhney, M.: Fundamentals of Customer Value. *CIO Magazine*, 4, 107–110 (2003).
14. Slater, S. F.: Developing a customer value-based theory of the firm. *Journal of Academy of Marketing Science* 25(2), 162–167 (1997).
15. Szwarc, P.: Researching Customer Satisfaction & Loyalty: How to Find Out What People Really Think. 1st edn. Kogan Page, London & Sterling (2005).
16. Yamamoto, G.T.: Understanding Customer Value Concept: Key to Success. First International Joint Symposium on Business Administration “Challenges for Business Administrators in the New Millennium, pp. 547–552 (2000).

## Development of Agricultural Insurance in the Russian Federation

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**Abstract.** The vast majority of lands in the Russian Federation belong to risky agriculture zones. They are characterized with high extent of risk, low profitability, lower workforce productivity, higher production cost of crop and livestock raising. Agricultural companies bear losses due to crop failure, death of animals and other emergency conditions (the flood, the drought, the fire, storm winds and epidemics). The government supports agricultural manufacturers granting 50% of the insurance premium of mandatory agricultural insurance. However, it is not popular in crop production industry, for instance. For recent 4 years the number of insured companies has been 5 times decreased. The same situation is observed in livestock raising industry. It is mainly caused by bureaucratization of the government support and absence of competition among insurance companies. Furthermore only 1-11% of insurance premium is recovered when insured emergency takes place. It is very low amount. In the Russian Federation policy holders (agricultural companies) do not trust insurance companies. Agricultural companies are forced to practice self-insurance. The study suggests easy and clear method to calculate insurance premium in crop production and livestock raising industries. Calculations are based upon net operating (marginal) income.

**Keywords:** Agricultural Insurance Market, Insurance Premium, Insurance Tariff.

### 1 Introduction

Agricultural activity is a complicated manufacturing process which product are intended to sale (end products) or internal use (feed stuff, seeds and organic manures) by agricultural companies. This process is influenced by many factors of natural, internal extensive and intensive and external origin.

Currently Russian agricultural market is partly dependent of export from European Union [1].

Food sovereignty and security of the Russian Federation depends on stable and effective development of agricultural activity in agricultural companies and significant increase of agricultural production under standard costs. Moreover, manufacturing of mandatory volumes of agricultural products and annual creation of the government trading stock will result in decreased inflation at the federal level [4].

Significant growth rates of agricultural production are not easy achievable in the Russian Federation every year (Table 1).

**Table 1.** Gross output of main agricultural products [10].

Products	2014	2015	2016	2017	2017 in % 2014
Grain after modification, m. ton	105.4	104.8	120.7	135.4	128.46
Sugar beet, m. ton	33.5	39.0	51.4	51.9	154.93
Potato, m. ton	31.5	33.6	31.1	29.6	93.97
Vegetables, m. ton	15.5	16.1	16.3	16.4	105.81
Poultry and beasts, thou. ton	12912	13,475	13,939	13,939	107.95
Milk, m. ton	30.8	30.8	30.7	30.7	99.68
Eggs, bn. Pcs.	41.9	42.6	43.5	43.5	103.82

The data from Table 1 proves stable and steady growth of gross output of main agricultural products in the Russian Federation (percents of growth are the following: grain – 28.46%, sugar beet – 54.93%, vegetables – 5.81%, poultry and beasts – 7.95%, eggs – 3.82%). Production of potato and milk is decreased on 6.03% and 0.32% consequently. Technological, managerial production conditions, soil and climate and other abiotic conditions significantly influence production volumes, quality and production costs of agricultural products in the Russian Federation.

The key drivers of farm profit or losses are production risks pertaining to price and the yield volatility of agricultural commodities [7]. The government funds risks in agricultural production.

## 2 Research Result and Discussion

### 2.1 Modern Condition in Russian Agriculture Market

The vast majority of agricultural lands for development of crop production and livestock raising are situated in risky agricultural zones. In these zones agricultural economic entities spend much more material, labor and financial resources on manufacturing of agricultural products than in zones with better conditions. Risky agricultural zones are characterized by lower workforce productivity and high production costs of crops and livestock raising. Moreover, in abovementioned zones agricultural economic entities (collective companies and farms) bear great losses due to partial and complete failure of crops and agricultural animals for the reason of emergencies such as chills, floods, the drought, fires, storm winds and epidemics etc.

For the last years the number of emergencies has grown and is still growing due to changed climate conditions in the Russian Federation. Hence it is necessary to consolidate role of management of prevention and decline of influence of emergencies on agricultural production or remedial actions of happened emergencies. However, to manage emergencies and their results in the particular agricultural economic entity it is necessary to have financial sources for prevention of emergencies and recovery of their results in crop production and livestock raising. It needs appropriate arrangement and development of biological asset insurance (here crops and agricultural animals are considered assets) in agricultural companies (collective enterprises and farms and private farms) [6].

It should be noted that insurance of biological activities are paid much attention in the Russian Federation. In order to develop agricultural insurance in the Russian Federation the law “About the government support of agricultural insurance” and introduction of amendments into the Federal law “About development of agriculture” dated 25.07.2011 No. 260 – FZ was created. According to abovementioned law agricultural insurance with the government support comprises insurance of property interests attributed to risks of loss (failure) of crops, perennial plants and agricultural animals.

In accordance with Federal law the following risks of loss (failure) of crops, perennial plants and cultivated plants are insured in case of:

- Impact of natural phenomena which are dangerous for agricultural products. These phenomena are the air and soil drought, dry hot wind, chills, the winterkill, damping out, the hailstorm, the dust storm, the ice crust, high water, floods, the underwater, the flowage, the landslide, the waterlogged soil, strong wind, the storm wind, the earthquake, the avalanche, the mudrock flow and the natural fire.
- Penetration and/or plaque formation in case of epiphytotic character.
- Damaged electric power supply, heat supply and water supply in case of the acts of God and under condition of insured cultivated plants grown in frame or reclaimed areas.

In accordance with the Federal law dated 25.07.2011 No. 260-FZ the government support is provided in case of insured risks of loss (failure) of agricultural animals due to the following events:

- zymotic diseases of animals included into the list approved by an authorized body, mass poisoning.
- the Acts of God (a lightning struck, the earthquake, the dust storm, the storm wind, strong snowstorm, the snowdrift, the flood, the rockslide, the avalanche, the mudrock flow and the landslide).
- Damaged electric power supply, heat supply and water supply in case of the acts of God if utilization of electricity, heating and water is mandatory for managing animals; fire.

However abovementioned legal regulations stated in the Federal law dated 25.07.2011 No. 260-FZ are not met appropriately. The data in Table 2 and Table 3 prove this fact.

Medium and small agricultural companies prefer a strategy “insurance of risks are shared with others” [3].

In the Russian Federation the only about 50% of the insurance premium is subsidized by the government. By comparison with American agricultural insurance market the government support for agricultural insurance is 60% of premium [2].

**Table 2.** Insurance condition of crops and perennial plants with the government support [10].

Index	2013	2014	2015	2016	2016 in % к 2013г.
1. The number of companies having the insurance agreement with the government support	4,663	5,827	2,751	913	19.58
2. The acreage stated in the insurance agreement, m. ha	11.7	12.8	8.3	3.8	32.48
3. Share of the acreage of insured plants, %	16.3	17.7	10.9	5	-
4. The amount insured, bn. EURO	2,289	2,657	1,946	1,435	62.68
5. Total amount of paid insurance premium, bn. EURO	133	153	109	71	53.11
6. Total amount of subsidies, bn. EURO	66	75	53	31	47.85
7. Shear of real refund of insurance premium paid from the government budget, %	49.3	49.2	49.1	44.5	-
8. The amount of insurance recovery, bn. EURO	18	20	13	8	43.30
in % to insurance premium	13.7	12.7	12.3	11.1	-

The data in Table 2 identifies condition of Russian agricultural insurance market and level of the government support of agricultural companies. In accordance with the data in Table 2 it should be noted that the number of insured companies in the crop production industry is getting less from year to year. The acreage stated in the insurance agreements is reducing (reduction is 80.42%) and the same concerns share of insured cultivated plants. The total amount of insurance premium paid in 2016 was reduced on 37.32% by comparison with 2013. Total insurance premium paid at the same period was reduced on 46.89%. Consequently, the number of subsidies in crop production industry was decreased on 52.15% and amount of insurance recovery – 56.70%.

Condition of livestock raising industry is relatively different. Here the number of insured livestock was significantly decreased in 2016 by comparison with 2013 (on 23.72%) and, consequently, the amount of insurance premium was decreased on 75.70% and paid insurance premium – on 73.75%. The government support has been reducing for the last years in livestock industry. Here the government support means the number of subsidies paid from the government budget to agricultural companies as the recovery of insurance premium.

**Table 3.** Insurance condition of livestock with the government support [10].

Indicators	2013	2014	2015	2016	2016 in % 2013
1. The number of companies having the insurance agreement with the government support	371	526	345	2,83	76.28
2. Livestock population stated in the insurance agreement, thou. of conditional heads.	1,729	4,303	4,777	4,046	234.01
3. Share of insured livestock, %	7	16.6	17.9	14.6	-
4. The amount insured, bn. EURO	470	877	1 031	825	175.70
5. Total amount of paid insurance premium, bn. EURO	5	10	10	9	173.75
6. Total amount of subsidies, bn. EURO	4	6	5	3	84.14
7. Shear of real refund of insurance premium paid from the government budget, %	49.5	48.3	48.3	36.8	-
8. The amount of insurance recovery, bn. EURO	-	0.11	-	0.70	-
in % to insurance premium	-	1.1	-	7.7	-

Reduction of the number of insured agricultural companies in crop production and livestock raising caused by some reasons. Mainly there are few insurance companies cooperating with agricultural companies in the Russian Federation. The second reason is not appropriately developed Russian agricultural insurance market and absence of confidential relations between agricultural companies and insurance companies.

## 2.2 Causes, Effects and Suggestion in Agricultural Market

The reason of inefficient development of agricultural insurance and absence of mass involvement of agricultural companies into insurance process might be also high price of insurance of biological assets (cultivated plants and livestock). It is caused by absence of real competition in the insurance market among insurance companies as their number is insufficient in this market.

For abovementioned reasons the vast majority of agricultural companies does not insure biological assets and prefers to do self-insurance i.e. the companies create internal financial resources to recover results of emergencies. In order to create such resources, the companies are to collect and reserve [5] insurance amounts for some years. Hence it should be suggested that establishment of internal financial resources is not quite important. Russian insurance market should be developed by attracting many insurance companies and foreign as well. In this way the insurance market will get active and increased number of insurance companies (the subjects) and insured agricultural companies (the objects) will cause competition between the subjects and reduction of insurance premiums.

Here more reasonable and easy methods are suggested for calculation of insurance premiums by insurance companies. These calculations might be introduced into the insurance agreements.



Method A. Crop production.

$$IP = (GO - VC) \times K \quad (1)$$

Where

IP – insurance premiums per 1 ha of crops of the specific plant, thou. EURO.

GO – gross output per 1 ha of crops of the specific plant estimated in fair value, thou. EURO.

VC – variable costs of production per 1 ha of the specific plant, thou. EURO.

K – insurance coefficient ( $K = n/100$ , n – number of years during which the company was under action of insurance)

Method B. Livestock raising.

$$IP = (FVE - FVB) \times K \quad (2)$$

Where

IP – insurance premiums calculated per 1 head of the specific kind of an animal, thou. EURO.

FVE - fair value of 1 head of the specific kind of an animal in the end of the fiscal year, thou. EURO.

FVB - fair value of 1 head of the specific kind of an animal in the beginning of the fiscal year, thou. EURO.

Implementation of suggested methods in insurance of biological assets (plants and animals) will encourage agricultural companies to involve into insurance process as the basis of insurance premiums is NOI (net operating (marginal) income).

### 3 Conclusion

The vast majority of lands in the Russian Federation belong to risky agriculture zones. They are characterized with high extent of risk, low profitability, lower workforce productivity, higher production cost and high risk of natural emergencies (the drought, chills, and epidemics of animals). In spite of stable and steady growth of production of the main agricultural products in non-monetary view Russian agriculture needs the government support. Agrarian sector is characterized by low profitability and high risks. It makes it unattractive for insurance companies. Russian government subsidizes only 50% of insurance premium in agricultural insurance.

Currently interest of agricultural companies belonging to crop production and livestock raising are losing interest to agricultural insurance. It is caused by the following factors:

- High bureaucracy of insurance process
- Low percentage (1-11%) of recovery from insurance premium
- Absence of competition among insurance companies. Farmers can't choose the insurance company.
- Unclear insurance conditions and complicated way to recover damage after the emergency.
- Absence of confidential relations between agricultural companies and insurance companies.
- Agricultural companies practice self- insurance from internal resources.

Easy and clear method of calculation of insurance premiums for crop production and livestock raising is suggested in this study. This method is based on net operating (marginal) income.

## References

1. Benesova, I., Maitah, M., Smutka, L., Tomsik, K., Ishchukova, N.: Perspectives of the Russian agricultural exports in terms of comparative advantage. *Agricultural Economics*, 63(7), 318-330(2017). DOI: 10.17221/344/2015-AGRICECON
2. Du, X., Feng, H., Hennessy, D.: Rationality of Choices in Subsidized Crop Insurance Markets", *American Journal of Agricultural Economics*, 99(3), 732-756(2017). DOI: 10.1093/ajae/aaw035
3. Meuwissen, MPM., Hardaker, JB., Huirne, RBM., Dijkhuizen, A.A.: Sharing risks in agriculture; principles and empirical results, *Netherlands Journal of Agricultural Science*, 49(4), 343-356(2001). DOI: 10.1016/S1573-5214(01)80022-1
4. Alborov, R., Kontsevaya, S.: Methodology development of valuation and accounting for land assets. *Economy of agricultural and processing enterprises (Экономика Сельскохозяйственных и Перерабатывающих Предприятий)*, 2, 29-32(2013). ISSN 0235-2494
5. Kontsevov, G.: Improving the valuation and the managerial accounting of costs in agricultural production. *Accounting in Agriculture (Бухучет в сельском хозяйстве)*, 1, 54-64(2015). ISSN 2075-0250
6. Shumkova, T.: State support in Agriculture. *Management: Theory and Practice (Менеджмент: теория и практика)*, 1-2, 66-72(2018). ISSN: 2310-0613
7. Spicka, J.: Global trends in risk management support of agriculture. In: Jan Hron (eds.), *Proceedings of international Scientific Conference Agrarian perspectives 19th*, Prague, pp.173 – 180. Czech University of Life Sciences, Prague (2010), ISBN 978-80-213-2123-6
8. Ministry of Russian Agriculture. <http://www.fagps.ru/docs2/> URL, last accessed 2018/10/14.
9. Consultant plus - Official Law Database. [http://www.consultant.ru/document/cons\\_doc\\_LAW\\_117362/](http://www.consultant.ru/document/cons_doc_LAW_117362/) URL, last accessed 2018/10/14.
10. Federal Russian state statistics service Rosstat. [http://www.gks.ru/wps/wcm/connect/rosstat\\_main/rosstat/ru/statistics/publications/catalog/doc\\_1140096652250](http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1140096652250), URL, last accessed 2018/10/14.

## **Ranking Score of Financial Condition and Fear of Bankruptcy to Evaluate Operation's Continuity of Dairy Milk Processing Companies: Evidence from the Republic of Belarus**

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**Abstract.** The article covers issues of bankruptcy detection in the context of dairy milk processing companies of the Republic of Belarus. Republic of Belarus is exporter of milk products i.e. more than 60% of products are exported abroad. Gross output of milk products is more than 7 thou tons. To keep successful functioning of dairy milk processing companies it is important to estimate financial condition of the companies and detect possibility of bankruptcy in time. The article contains 11 models of bankruptcy detection, which provide the basis for the new model taking into account specificity of dairy milk processing industry. Suggested methodology of ranking score to detect threat of bankruptcy classifies financial coefficients by reliability for specific dairy milk processing company. Condition of the company may be evaluated as crisis, pre-crisis, unstable normal or absolute. This study includes examples of calculation for 6 major dairy milk processing companies of the Republic of Belarus. These calculations prove the fact that possibility of bankruptcy is unstable every year. Such condition might be caused by many internal and external factors such as sanctions, embargo, restructuration and loss-making company takeover. Practically implemented this methodology should only be included into the notes of accounting reports of the company. It may be helpful for auditors and external users to estimate stability of the company and risk of bankruptcy and take reasonable decision about management of risks.

**Keywords:** Dairy industry, Milk processing, Financial analysis, Accounting.

### **1 Introduction**

Milk processing industry is a brand identity of the food industry in the Republic of Belarus. It produces milk, butter, cheese, ice cream, tinned milk etc. Milk processing industry is an important part of the food facility of the country. Hence, the financial

condition of milk processing companies should be done in time in order to estimate financial condition of the company and reveal threat of bankruptcy [15]

According to IAS [8] the concept of accounting report preparation supposes that company's activity is continuous. It is one of the key suggestions in case of preparation of accounting reports of all companies regardless their form of ownership. This concept suggests that steadily developed company continues its activity without temporary or target limits. One of the key reasons of interrupted activity of the company is bankruptcy. If the analysis of financial and operational activity of the company reveals risk of bankruptcy the activity of this company should not be considered continuous. If the company is under bankruptcy and no methods of solvency recovering are helpful it is closed down and its property is sold to liquidate debts [11]. Under growing instability of environment, the company is expected to implement special actions such as internal control and permanent monitoring of external changes of the market in order to avoid bankruptcy of the company.

There are a lot of methodologies of bankruptcy risk estimation and risk management algorithms described in Russian [2, 9, 10, 14], American and European [1, 5, 6, 12] studies. However, their implementation sometimes does not provide real condition and the ways for its correction. Some models include wasteful calculations and their results are not convenient to be read by managers. Hence, they provide implicit information about stability of functioning of the company, so it is insufficient for taking reasonable management decisions.

The article is aimed to estimate financial condition of major dairy milk processing companies of the Republic of Belarus and develop advanced methodology of bankruptcy risk detection.

The article involves the following key items:

- Description of modern condition of production, processing and consumption of milk in the Republic of Belarus.
- Suggestion of advanced methodology of bankruptcy risk detection with regard to specificity of dairy milk processing industry.
- Estimation of financial condition of 6 major milk processing companies

## **2 Materials and Methods**

### **2.1 Key Factors of Milk Processing Industry of the Republic of Belarus**

For the last 5 years the Republic of Belarus has been keeping the position among 5 major exporters of milk products in the world. Its share in the total worldwide export of milk is 5% by the end of 2017. Key importers of Belarusian milk products are EU countries [4].

Agriculture of the Republic of Belarus traditionally specifies in milk production and processing. Relative share of milk in the structure of saleable agricultural products is more than 25%.

The Republic of Belarus exports more than 60% of milk products. Over recent years dairy milk processing industry has been disbursing government investments in accordance with special support program.

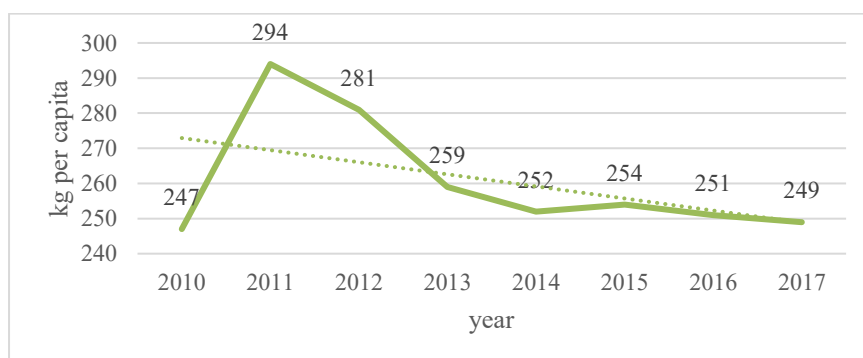
**Table 1.** Key production and economic factors of dairy milk processing industry development in the Republic of Belarus in the period 2010 – 2017.

Indicator	2010	2014	2017	2017 in % to 2010
Yearly average cow population, thousands of heads	1,445	1,525	1,502	103.9
Gross output of milk, thousand tons.	6,624	6,703	7,322	110.5
Milk yield per cow, kg.	4,630	4,508	4,943	106.8
Final disposal price of 1 ton of milk, thou. RUB	854	4,231	5,534	648.0
Profit margin, %	12.1	18.9	28.3	16.2

Source: Statistical compilation Agriculture of the Republic of Belarus, own calculations

According to the data from Table 1 cow population has grown on 3.9%, gross output of milk has increased on 10.5% and capacity of cows – on 6,8% for the abovementioned period. Final disposal price of milk has 6.5 times increased from 2010 to 2016. Profitability of dairy milk processing industry was 28.3% in 2016 that is higher on 16.2% by comparison with 2010.

Analysis of milk and milk products consumption in the Republic of Belarus per capita in 2010 – 2017 (Fig. 1)



**Fig. 1.** Consumption of milk and milk products in the Republic of Belarus in 2010-2017, kg/person [16].

Analysis of Fig.1 obviously evidences the trend of decreased consumption of milk and milk products per capita. From 2011 to 2017 the consumption decreased on 18.1% and in 2017 it was 249 kg per person. This is due to a general decline in household income. It should be noted that the Republic of Belarus keeps 1 position among EU countries in production and consumption of milk and milk products per capita.

## 2.2 Methodology

This study involves analysis of 6 major milk processing companies in the Republic of Belarus i.e. Babushkina krynka JSC, Savushkin product JSC, Bellakt JSC, Milkavita JSC, Minsk dairy plant number 1 JSC and Lepel JSC. Data for analysis was taken from the database of accounting reports [7]

Analysis of bankruptcy risk made from 11 models in Table 2 proved that the specificity of dairy milk processing industry was not taken into account completely. Therefore suggested model was developed in order to take into account specific features of agricultural milk processing companies. In this model financial coefficients are classified by reliability for milk processing companies, ranking scores of financial condition, mark scores of bankruptcy risk and continuity of operation.

**Table 2.** Summary of bankruptcy risk estimation of Babushkina krynka, JSC 2013–2017 [3].

Indicator	2013	2015	2017
Two-factor model by Altman	Less 50 %	Less 50 %	Less 50 %
Modified five-factor model by Altman	50 %	High	High
R.Taffler and G.Tishow model	Low	Middle	Low
Model by Springate	Low	High	High
Four-factor model IGEA	Till to 10 %	90–100 %	90–100 %
Model by Lis	High	High	High
Model by O.P. Zaytseva	Low	High	High
Model by R.S.Sayfullin and G.G.Kadykova for financial condition estimation	Unstable	Unstable	Unstable
Model by G.V.Savitskaya for production companies	Low	Very High	Very High
Model by G.V.Savitskaya for agricultural companies	Very Low	Very Low	Very Low
Model by Biver (Biver's coefficient, standard value not less than 0,17 )	0,61	0,28	0,01

Based upon methodologies from Table 2 suggested methodology was specified with regard to estimation of financial condition of milk processing agricultural companies. The criteria for financial condition estimation were calculated on the basis of practical functioning of Russian milk processing agricultural companies.

Analysis of financial condition of milk processing companies revealed common factors of liquidity and financial sustainability and specific factors of monetary flows.

It should be noted that Russian methodologies [9, 14] of bankruptcy risk estimation are focused on functioning with internal funds while American methodologies [1] are based upon loan capital. Suggested methodology takes into account both internal and loan funds, monetary flows allowing estimating capability of the company to pay debts and available cash assets proving solvency of the company.

Classification of liquidity and financial sustainability coefficients and specific factors of monetary flows is specialized for milk processing agricultural companies. Rated from absolute to crisis financial condition is defined by 13 coefficients. Common

liquidity factors and financial sustainability factors (coefficients) were taken as factors of financial condition and their values are calculated. These factors are:

1) Absolute liquidity (K1). Standard value of this coefficient should be equal or more than 0.2. The most appropriate range of its values for milk processing companies is 0.15 – 0.2 with regard to specificity of this industry.

2) Intermediate (fast) liquidity (K2). Standard value of this coefficient is 0.7. It should be noted that this value is not sufficient sometimes as major part of liquid assets is presented by accounts receivable in some companies. It is difficult to be collected in time. In case of milk processing companies, desirable value of this coefficient is 1 or more.

3) Current liquidity (K3). According to the legislation of the Republic of Belarus standard value of this coefficient for milk processing companies should be taken  $\geq 1.3$ .

4) Total liquidity (K4). Recommended value of this coefficient for milk processing companies belongs to range from 1 to 2. Lower value of this coefficient means that current assets are insufficient for payment of small debts.

5) Provision with internal funds (K5). According to the legislation of the Republic of Belarus standard value of this coefficient for milk processing companies should be more than 0.2. In researches by G.V. Savitskaya [13] standard value of this coefficient is taken from 0.2 to 0.5. The closer value to 0.5 the more resilient the company is.

6) Covering of current assets with internal funds (K6). Standard value of this coefficient is more than 0.1 for milk processing companies;

7) Autonomies (financial independency) (K7). According to the legislation of the Republic of Belarus standard value of this coefficient should not be less than 0.4 – 0.6 in order to consider the company financially stable.

8) Capitalization (K8). According to the legislation of the Republic of Belarus standard value of this coefficient should not be more than 0.1.

9) Financial stability (K9). Standard value of this coefficient should be equal or more than 0.75. If the value of this coefficient is in the range from 0.8 to 0.9 the company moves in positive trend and its financial condition is stable.

10) In-house solvency (K10). Standard value of in-house solvency coefficient should not be less than 0.1 at international level. It is individual value for each company depending on production and financial operations of the company.

Specific factors of monetary flows (coefficients):

11) Cash cover of debts (K11). Standard value of this coefficient should be 0.17 – 0.45 for milk processing company;

12) Self-financing of investment activity (K12). Standard value of this coefficient should be more than 1. If it is less than 1 the company should use loans for investment activity.

13) Self-financing of payments within financial activity (K13). Standard value of this coefficient should be more than 1 otherwise there are corporate risks for milk processing agricultural companies.

Suggested methodology of bankruptcy risk estimation is based upon summarized data about national and foreign methodologies. Milk processing agricultural companies were classified by the extent of reliability. Each effective value of the coefficient was characterized by definite mark score qualifying the company to some class (5 classes

correspond to 5 financial conditions: absolute, normal, unstable, pre-crisis and crisis). Achieved criterion is provided with the class: absolute financial condition – 10 scores, normal financial condition - 8 scores, unstable financial condition – 6 scores, pre-crisis financial condition – 4 scores, crisis financial condition - 2 scores. Distribution of financial coefficients by reliability classes for milk processing company is provided in Table 3.

**Table 3.** Distribution of financial coefficients by reliability classes for milk processing agricultural company.

Indicator	Absolute	Normal	Unstable	Pre-crisis	Crisis
K1	$\geq 0.2$	0.2–0.15	0.15–0.10	0.10–0.05	$\leq 0.05$
K2	$\geq 1$	0.7–1	0.7–0.6	0.6–0.4	$\leq 0.4$
K3	$\geq 1.5$	1.5–1.3	1.3–1.0	1.0–0.5	$\leq 0.5$
K4	2	1–2	0.9–1.0	0.6–0.9	$\leq 0.6$
K5	$> 0.5$	0.2–0.5	0.1–0.2	0.1	$< 0.1$
K6	$> 0.5$	0.3–0.5	0.1–0.3	0.1	$< 0.1$
K7	$\geq 0.6$	0.4–0.6	0.4–0.3	0.3–0.1	$< 0.1$
K8	1	1.0–1.5	1.5–1.7	1.7–2.0	$> 2$
K9	0.8–0.9	0.8–0.75	0.75–0.65	0.65–0.50	$< 0.50$
K10	$> 0.1$	0.1	0.1–0.08	0.08–0.05	$< 0.05$
K11	$> 0.45$	0.17–0.45	0.17–0.12	0.12–0	$< 0$
K12	$\geq 1$	0.6–1	0.6–0.4	0.4–0	$\leq 0$
K13	$\geq 1$	0.6–1	0.6–0.4	0.4–0	$\leq 0$

All scores are summed and the total score presents the ranking of the milk processing agricultural company (Table 4).

**Table 4.** Ranking of financial condition of milk processing agricultural companies.

Amount	Rating	Criteria
105-130	Absolute	High efficient company, absolute financial stability
79-104	Normal	Normal financial stability
53-78	Unstable	Unstable financial condition
27-52	Pre-crisis	Insolvent and inefficient company, pre-crisis financial condition
0-26	Crisis	Bankruptcy

### 3 Results and Discussion

Calculation of suggested methodology of bankruptcy risk estimation and disclosure of information about continuity of functioning in comments of accounting (financial) reports and their remarks is provided for Babushkina krynka JSC over the period of 2015-2017 (Tables 5 and 6). Disclosure of information about continuity of functioning is suggested in comments to accounting (financial) reports and remarks about financial



condition of the company divided into reliability classes are provided in view of the table (Table 6).

**Table 5.** Score estimation of bankruptcy risk for the agricultural company Babushkina krynka JSC in 2015–2017.

Indicator	2015	Score	2016	Score	2017	Score
K1	0.04	2	0.02	2	0.02	2
K2	0.47	4	0.4	2	0.49	4
K3	0.72	4	0.66	4	0.78	4
K4	0.3	2	0.29	2	0.37	2
K5	−0.37	2	−0.5	2	−0.28	2
K6	−2.11	2	−2.25	2	−1.27	2
K7	0.37	6	0.33	6	0.29	6
K8	1.74	4	2.02	2	2.45	2
K9	0.72	6	0.69	6	0.60	4
K10	−0.28	2	−0.33	2	−0.22	2
K11	−0.18	2	0.06	4	0.06	4
K12	−1.03	2	0.39	4	0.66	8
K13	−0.35	2	0.10	4	0.06	4
Total score	-	40	-	42	-	46
Desision	Pre-crisis		Pre-crisis		Pre-crisis	

Results of calculations of suggested methodology of bankruptcy risk estimation and information about continuity of functioning for some milk processing agricultural companies Babushkina krynka JSC, Savushkin product JSC, Bellakt JSC, Milkavita JSC, Minsk dairy plant number 1 JSC, Lepel JSC in 2015-2017 is provided in Table 6.

**Table 6.** Score estimation of bankruptcy risk of milk processing agricultural companies in the Republic of Belarus in 2013-2017.

Firm	Score	2015	Score	2016	Score	2017
Babushkina krynka	40	Pre-crisis	42	Pre-crisis	46	Pre-crisis
Savushkin product	70	Unstable	88	Normal	110	Absolute
Bellakt	66	Unstable	48	Pre-crisis	110	Absolute
Milkavita	32	Pre-crisis	36	Pre-crisis	64	Unstable
Minsk dairy plant 1	60	Unstable	80	Normal	80	Normal
Lepel	26	Crisis	–	–	–	–

Changes in financial condition of milk processing agricultural companies over considered period are caused by some internal and external factors such as global economic crisis, sanctions [17] and embargo of import of milk products into the Russian Federation. These factors result in decreased benefit and earning capacity of the company making its financial condition worse. Internal factors involve business combination and restructurisation of milk processing companies. Acceding loss-

making company degrades financial condition of more profitable companies (for instance the company Bellakt in 2015). The topic of further researches might be prediction of bankruptcy risks.

## 4 Conclusion

Milk production industry is one of the most important industries providing high quality of food for population of the country. Moreover, the Republic of Belarus is the major exporter of milk products therefore the estimation of financial condition of the companies is of great importance.

Suggestion of continuous accounting reports of the company provide diagnostic of bankruptcy risk in time.

The article contains critical evaluations of bankruptcy diagnostic models and suggests the model of bankruptcy risk estimation specified for milk processing company.

Each company was classified by definite score. This score is based upon coefficients of financial condition and calculated with regard to specificity of milk processing industry. Condition of the company made by the sum of scores may be evaluated as crisis, pre-crisis, unstable, normal or absolute.

Calculation for 6 major milk processing companies in the Republic of Belarus reveals fluctuate character of bankruptcy threat every year. It is caused by some internal and external reasons such as sanctions, embargo, restructurisation and loss-making company takeover.

This calculation is suggested to be attached to accounting reports. It will help auditors and other users to estimate continuity of functioning of the company and take reasonable decision concerning management of risks.

## References

1. Altman, E. I., Haldeman, R. Narayanan, P.: Zeta analysis: A new model to identify bankruptcy risk of corporations. *Journal of Banking & Finance*, Vol. I., pp. 29-54. (1977)
2. Bulava, I. Termination of companies and the bankruptcy of Russian enterprises. *Journal Finance, money, investment*, 4(44), 11-16(2012)
3. Chachotkin, S.: Improving the financial risk management system (Совершенствование системы управления финансовыми рисками): BGSNA, Gorki (2016).
4. Dairy industry. [http://www.uniter.by/upload/Dairy\\_industry.pdf](http://www.uniter.by/upload/Dairy_industry.pdf) URL last accessed 2018/10/14
5. Doubek, V., Švasta, J., Blažková, L.: Agricultural trade on the example of milk from the perspective of the multi-criteria analysis, *Agricultural Economics*, Vol. 58, No. 7, pp. 315-323. ISSN 0139-570X (2012)
6. Foltínová, A. Špička, J.: The use of controlling in agricultural enterprises and their competitiveness", *Agricultural Economics*, Vol. 60, No. 7, pp. 314-322. (2014) ISSN 0139-570X.

7. GIVTS Ministry of Agriculture and Food (ГИБЦ Минсельхозпрода) <http://givc.by/services/sbor-obrabotka-analiz-otchetnosti-predpriyatiy-apk/pk-bukhstat/> URL last accessed 2018/10/14
8. International Financial Reporting Standard (IAS) "Presentation of financial statements" (valid on Belarus Republic at 30.12.2016 № 1119/35) <http://pravo.by/> URL last accessed 2018/10/14
9. Melnik, M.: Economic analysis in auditing (Экономический анализ в аудите). Revised edition. UNITY Publishers, Moscow (2007)
10. Ovchinnikova, N.N.: Evaluation of the continuity of the organization: problems and their solution. Journal Current issues of economic sciences (Актуальные вопросы экономических наук), 4(2) 139-144 (2009).
11. Rozsa, A.: Financial performance analysis and bankruptcy prediction in hungarian dairy sector. Annals of the University of Oradea: Economic Science, Vol. 23, No. 1, pp. 938-947. (2014) ISSN 1222-569X.
12. Rättinger, T., Bošková, I.: Strategies and effects of milk producers' organizations in the Czech Republic, Agricultural Economics, Vol. 59, No. 3, pp. 113-124. ISSN 0139-570X. (2013)
13. Savitskaya, G.: Economic analysis. 11 edn. Novoe znanie, Moscow (2005)
14. Soldatov, A., Korzhavina, E.: Analysis of financial characteristics of the continuity of the organization. Proceedings of the International Scientific Conference "The strategy of socio-economic development of society: managerial, legal, economic aspects", pp. 142–145. Timiryazev University, Moscow (2016)
15. Špička, J.: The efficiency improvement of Central European corporate milk processors in 2008 – 2013", Agri on-line Papers in Economics and Informatics, Vol. 7, No. 4, pp. 175-188. (2015) ISSN 1804-1930.
16. Statistical compilation Agriculture of the Republic of Belarus. Statistical committee, Minsk (2018)
17. Smutka, L., Špička, J., Ishchukova, N., Selby, R.: Agrarian import ban and its impact on the Russian and European Union agrarian trade performance", Agricultural Economics, vol. 62, no. 11, pp. 493-506, (2016) ISSN 1805-9295, DOI 10.17221/294/2015-AGRICECON

## Activity Based Costing and Process Simulations

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**Abstract.** The article is focused on the usage of Activity Based Costing (ABC) and process modelling, Business Process Model and Notation (BPMN) to be precise for simulation modelling. This connection is applied to the predictive simulation of costs of Alzheimer's Disease (AD). The aim of the article is to describe the application of these two methods in a new problem domain and in doing so possibly outlay a new way of use. The article builds on the already existing applications of the combination of ABC and BPMN on specific processes and elaborates it in a more abstract process which operates with a high rate of coincidence.

**Keywords:** Activity Based Costing, BPMN, Business Process Management, Simulation, Model.

### 1 Introduction

At present time, there have been trends of perceiving businesses in a more complex way. This holistic view of businesses then leads to a much bigger interconnectedness of individual parts of the business. This article focuses on the Activity Based Costing method (ABC) and process perception of a business. ABC is an accounting and calculation method which assigns the business's costs to individual activities. These activities are the basic building component in analysing and modelling processes.

The article explores the connection of ABC and modelling processes with the help of Business Process Model and Notation (BPMN) with the goal of predicting costs of the Alzheimer's Disease. Prediction is realized with the help of a modelled process and simulations of its course. Connecting ABC and BPMN is not a frequent connection and therefore opens possibilities of interesting expansion of well-known BPMN notation in economic sector. BPMN and Time Driven Activity Based Costing were used in the article [17] where the testing and evaluation of abilities of chosen BPM tools in relation to the model of costs based on TD ABC were presented. The article [2] demonstrated the use of TD ABC when analysing the proposed system with the help of BPMN for state universities. Articles [8,9] show detailed process model of business sources and administering the costs inspired by the accounting principles based on the activity (ABC).

## 2 Activity Based Costing

The advantage of this method when compared with others is the effort of evaluating each single activity instead of an evaluation based on allocation bases. [12,13] This primarily demands a total change in the business perception and in the approach to the costs calculation, e.g. the separation of costs to fixed and variable is redundant. On the other hand, thanks to this method, it is possible to evaluate the products in areas where the classic calculation methods do not apply, or the conditions are specific, for example, a small lot production and the costs of machine adjustments. Typically, it is a fixed cost, but in case of a small lot production where the machine has to be adjusted for each product, otherwise, it would be a variable cost. The second area is work sharing, e.g. a group of experts which influences the functioning of nearly the whole business.

ABC method is based on assigning costs to particular activities which are furthermore grouped into a process where the costs of the whole process are aggregated. Especially the determination of indirect and overhead costs of particular activities is problematic. That can be in practice solved in different ways, for example, the principle of causal link or the principle of tolerability [4,5].

We shall define the basic terms which are bound to the costs' allocation (according to [2,8]):

- Activity – primary elementary component
- Function – an alternative to activity, it is possible to group them, both can define inputs and optionally outputs
- Process – grouping of activities which with the help of the inputs create outputs, their further division into main and supporting is possible
- Sources – inputs into process or activity, using them creates costs
- Costing object – they are the reason for source usage, they are valuable for business
- Quantity of reference – once again an alternative to the costing object, the reason of source usage

If the costs are defined this way, it is then very easy to use it in the area of process modelling where it is possible to predict how the costs will change when altering particular parts of the process.

## 3 Process Model and Simulation

At first, we need to define what process is, and the following definition serves that purpose: „... a collection of inter-related events, activities, and decision points that involve a number of actors and objects and that collectively lead to an outcome that is of value to at least one customer.“ [10]. The similarity of process outlook on costs area is visible in the definition.

A relatively young but plentifully used Business Process Model and Notation (BPMN) is used in the article. "The Business Process Model and Notation (BPMN) is a graphical notation that depicts the steps in a business process. BPMN depicts the end to end flow of a business process. The notation has been specifically designed to

coordinate the sequence of processes and the messages that flow between different process participants in a related set of activities." [6]. BPMN was chosen mainly because of the possibility of wider usage of usable elements which allow to accurately capture reality and to work with different abstraction.

Primary elements of BPMN notation used in the presented model are defined in the following part.

- Activity (rectangle) is the primary part of the process, work is done in the activity, takes a certain amount of time and can use sources and produce outcomes
- Events (circle) – show an impulse or execution of an event in the process, do not take any time and serve to show the change of state and dynamics in a process
- Gateways (rhomb) – manage the flow of the process and show its logical branching and merging
- Artefacts – show reports, documents and other additional elements of different importance. For this article, the key element is the one according to which the simulation is managed

#### **4 Process Model of Alzheimer's Disease**

The possibility of abstracting away particular parts of the process that BPMN allows was crucial for creating the model of Alzheimer's disease. Due to its complexity, the exact depiction of the disease's process including all the details would be an enormously complicated process. That is the reason why this model was simplified and reduced only to the aspects of the disease that generate costs.

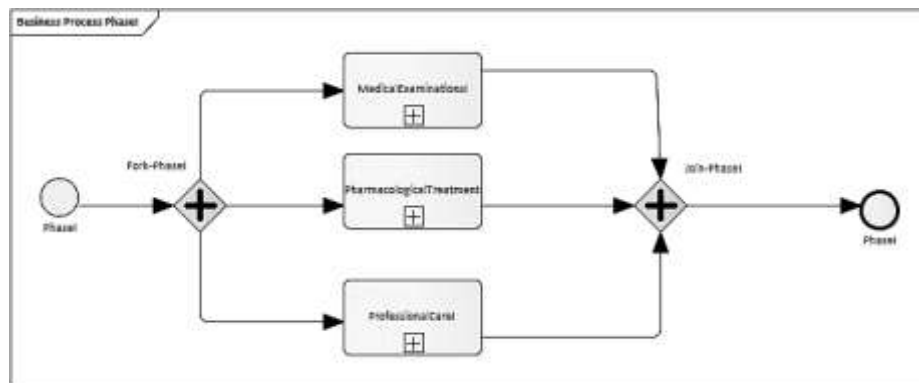
This article is focused on the application of Enterprise Architect tool, since it is a widely used tool to model SW and it works inherently with the BPMN notation and its simulation. To be able to convey a simulation of the process with regard to the costs, it was needed to add BPSim [3,7] complement to EA which allows specifying simulation details more into depth and provides better outputs with the possibility of specification of its own markers of the process performance.

Alzheimer's disease process has its specifics and that is the reason why it is suitable to use simulation methods when predicting the costs of the process. It is mostly for situations when particular progress of Alzheimer's disease might differ in fundamental points, whether it comes to the duration of the process or different drug dosage based on the progress of the disease. All of these facts might be reflected in the size of costs or in their structure.

This model and its simulation, therefore, combine determining of simulation by time as well as data. Decision making on the basis of data is solved here with the help of Minimal Mental State Examination (MMSE) value, which shows the gravity of the disease. In practice, this value is determined on the basis of examination [15]. In this process, it is a generated variable when initiating each instance of the process. Time viewpoint is then logically used for the duration of the illness and the periodicity of particular operations such as medical check-ups and costs of drugs [14,16].

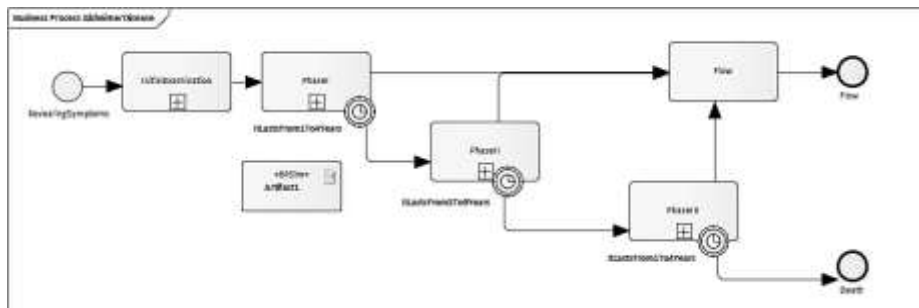
#### 4.1 Disease Model and Costs Calculation

The model is focused on the activities which generate costs in the duration of the disease. It is mainly three groups of activities, medical examinations, costs of drugs and other professional care. This distribution is shown in the **Fig.1**. Phase I. These overall categories (in the model represents by sub processes) are then divided into individual atomic activities. Other specific examples are found in the process.



**Fig.1.** Phase I.

Furthermore, the course of the disease in time intervals is shown. Because of these reasons, the disease is divided into three phases, since each requires a different approach towards the patient – as shown in **Fig. 2**. Alzheimer Disease. Individual phases are then divided into sub-processes according to the logic described above. An example of a subprocess of a disease, which is managed by the MMSE score, is the subprocess of pharmacological treatment in **Fig. 3**. Pharmacological Treatment. The decision making about the choice of drugs takes place in the subprocess and the subprocess is terminated if the drop of the score is too fast.



**Fig. 2.** Alzheimer Disease.

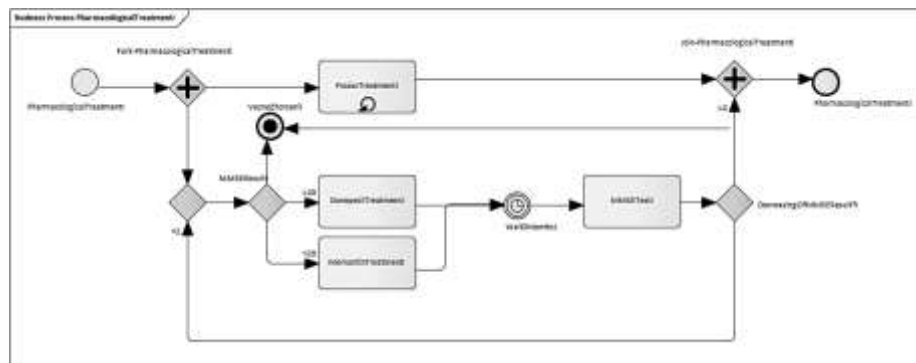


Fig. 3. Pharmacological Treatment.

## 5 Results

The goal of the simulation was not to calculate the real costs of the disease but to verify the connectedness of BPMN and ABC on an unusual practical problem. The results of the simulation are presented as constituent sums of individual activities and the sum of costs. These costs were then divided into individual constituent parts with the help of ABC principles. ABC method can be, thanks to its nature, used for better transformation of costs information taken from regular accounting data. It is therefore not a factual implementation, since a factual implementation of ABC is a very costly and complicated matter. The following Table 1 - simulation results in BPSim module shows chosen results of the simulation that was carried out. It is about the activity of Memantin application in the Alzheimer's Disease process. It depicts the activity in the first phase of the disease which is often repeated in the other phases, particular phases are differentiated by Roman numerals in the name of the activity.

Table 1 - simulation results in BPSim module

Category	Element	Parametr	Result
Control	AlzheimerDisease	Number Of Processes Completed	100
Control	AlzheimerDisease	Number Of Processes Started	100
Control	AplikaceMemantinuI	Number Of Tokens Arrived	900
Control	AplikaceMemantinuI	Number Of Tokens Compensated	0
Control	AplikaceMemantinuI	Number Of Tokens Completed	800
Control	AplikaceMemantinuI	Number Of Tokens Started	900
Control	AplikaceMemantinuI	Number Of Tokens Terminated	100
Cost	AplikaceMemantinuI	Total Completion Cost	2025000
Cost	AplikaceMemantinuI	Total Time Cost	0
Control	AplikaceMemantinuII	Number Of Tokens Arrived	1900
Control	AplikaceMemantinuII	Number Of Tokens Compensated	0



Control	AplikaceMemantinII	Number Of Tokens Completed	1800
Control	AplikaceMemantinII	Number Of Tokens Started	1900
Control	AplikaceMemantinII	Number Of Tokens Terminated	100
Cost	AplikaceMemantinII	Total Completion Cost	4275000
Control	AplikaceMemantinIII	Number Of Tokens Arrived	700
Control	AplikaceMemantinIII	Number Of Tokens Compensated	0
Control	AplikaceMemantinIII	Number Of Tokens Completed	700
Control	AplikaceMemantinIII	Number Of Tokens Started	700
Control	AplikaceMemantinIII	Number Of Tokens Terminated	0
Cost	AplikaceMemantinIII	Total Completion Cost	1575000
Cost	AplikaceMemantinIII	Total Time Cost	0

From the results shown above it is clear that the simulation took place 100 times (Number of Processes Started) and all the simulations were finished. The activity of Memantin application examined here was initiated in total of 900 times in the first phase and 100 activities were forcefully terminated. The sum total of the activities was 8,370,000 CZK and the value of Total Time Cost that equals zero shows that no variable costs were entered, and everything was calculated with fixed costs. Fixed costs within the simulation are always calculated at the initiation of the activity. In this process, this setting shows the state when each time a package of drugs is opened, which is paid for at one time. Those are only chosen data which deliver results based on the simulation setting. It is similar in other phases. Phase three is specific because all the activities were finished successfully, and this phase was finished correctly.

### 5.1 Application of the Simulation Results on ABC

The template for costs assigning according to the ABC method was taken from [11] and was adjusted to the needs of the simulation. The final chart is too extensive to be shown wholly in the article; therefore, only parts which are connected to the aforementioned activity are depicted.

Table 2. Phase cost allocation shows the sum total of costs of pharmacological treatments in individual parts of AD in lines 3.1.x. Allocate lines then show the division of costs of Memantin application activity to individual phases of pharmacological treatment. Table 3. Conversion based on unit costs shows the sum total of costs based on unit costs and count.

**Table 2.** Phase cost allocation.

Pharmacological treatment					
3.1.1	3 274 840	<----- Allocation of Costs to Activity 4.2 ----->			
3.1.2	14 925 480	Allocation	Allocation		
3.1.3	5 365 500	Percent	Amount		Activity Name
Allocate 3.1.1 >		62%	2 025 000	Memantin	
Allocate 3.1.2 >		29%	4 275 000	Memantin	
Allocate 3.1.3 >		29%	1 575 000	Memantin	
Sub Totals			7 875 000		

**Table 3.** Conversion based on unit costs.

		Total	Unit	Total
Activities per Tab 4	Output Metric (Activity Driver)	Units	Cost	Cost
Memantin	Count of activities	3500	2 250	7 875 000

## 6 Conclusion

Creation of our own ABC model for the article brought several problems. One of those is the problem of price determination of individual operations in medical and pharmacological treatments. The second problem is the fact that AD is not precisely described in medical literature and the exact process definition is therefore unknown. Because of the aforementioned reasons it is not possible to consider the data gathered thanks to the simulation to be true, but the article still serves as an illustration of the way which may be taken.

The article shows a possible way of using the process simulation when simulating costs. Unlike already published articles, this article is focused on the abstract process of the Alzheimer's Disease which requires work with the probability rate mainly due to the fact that the disease cannot be perfectly described.

## 7 References

1. Alves, R.J.V., Etges, A.P.B. da S., Neto, G.B., Polanczyk, C.A.: B Activity-Based Costing and Time-Driven Activity-Based Costing for Assessing the Costs of Cancer Prevention, Diagnosis, and Treatment. *Value in Health Regional Issues*, 17, 142–147 (2018). DOI: 10.1016/j.vhri.2018.06.001.
2. Araújo, M. B., Filho, B. A., & Gonçalves, R. F.: Business Process Management Notation for a Costing Model Conception. *Brazilian Journal of Operations & Production Management*, 13(3) (2016) DOI:10.14488/BJOPM.2016.v13.n3.a2.
3. BPSim.org., <http://bpsim.org/>, last accessed 2018/03/19.
4. Brimson, J.A.: *Activity accounting: an activity-based costing approach*. 1st ed. Wiley, New York, 1991.
5. Bruns, W.J., Kaplan, R.S.: *Accounting & management: field study perspectives*. Harvard Business School Press, Boston (1987).
6. Business Process Model and Notation (BPMN™), <https://www.omg.org/bpmn/>, last accessed 2018/06/14.

7. Business Process Simulation Specification. <http://www.bpsim.org/specifications/>, last accessed 2018/04/26.
8. Cartelli, V., Di Modica, G., Manni, D., Tomarchio, O.: A Cost-Object Model for Activity Based Costing Simulation of Business Processes. In: O'Conner, L. (ed.) 2014 European Modelling Symposium (EMS2014), pp. 221-226. Pisa, Italy (2014). DOI: 10.1109/EMS.2014.41.
9. Cartelli, V., Di Modica, G., Tomarchio, O.: A Resource-aware Simulation Tool for Business Processes. In: Obaidat, M. S., Holzinger, A. Van Sinderen, M., Dolog, P. (eds.) proceedings of the 11th International Conference on e-Business - Volume 1: ICE-B, pp. 123-133, Vienna, Austria (2014). DOI: 10.5220/0005067001230133.
10. Dumas, M.: Fundamentals of Business Process Management. 1st ed. Springer, New York, (2013).
11. Excel Spreadsheets, [http://www.exinfm.com/free\\_spreadsheets.html](http://www.exinfm.com/free_spreadsheets.html), last accessed 2018/04/04
12. Jalalabadi, F., Milewicz, A., Shah, S., Hollier, L., Reece, E.: Activity-Based Costing. *Seminars in Plastic Surgery*, 32(November 2018), 182–186. (2018) DOI: 10.1055/s-0038-1672208.
13. Kaplan, R.S., Anderson, S.R.: Time-driven activity-based costing: a simpler and more powerful path to higher profits. *counting & management: field study perspectives*. Harvard Business School Press, Boston (2007).
14. Kuca, K., Mohelska, H., Maresova, P., Valis, M.: Alzheimer's disease and its treatment costs: case study in the Czech Republic. *Neuropsychiatric Disease and Treatment*, (November 2015), 2349-2354 (2015). DOI: 10.2147/NDT.S87503.
15. Marešová, P., Dolejš, J., Kuca, K.: Call for a Uniform Strategy of Collecting Alzheimer's Disease Costs: A Review and Meta-Analysis. *Journal of Alzheimer's Disease*, 63(1), 227-238 (2018). DOI: 10.3233/JAD-171028.
16. Marešová, P., Zahálková, V.: The economic burden of the care and treatment for people with Alzheimer's disease: the outlook for the Czech Republic. *Neurological Sciences*, 37(12), 1917-1922 (2016). DOI: 10.1007/s10072-016-2679-6.
17. Pihir, I., Tomicic-Pupek, K., & Vrcek, N.: Challenges of Processes Simulation with Dynamic Batch Processing Activities. *Croatian Operational Research Review*, 9(1), 99-113 (2018). DOI: 10.17535/corr.2018.0009.
18. Three Levels of Process Modeling with BPMN, <https://methodandstyle.com/three-levels-of-process-modeling-with-bpmn/>, last accessed 2018/03/19
19. Weillkiens, T. W.: OCEB certification guide: business process management, fundamental level., Elsevier, Waltham (2011)

## **Slovakia after the Introduction of the Euro (overview of the period 2009-2011)**

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**Abstract.** The study addresses the main macroeconomic implications of introduction of the single currency in Slovakia. The main objective is to present the real impact of the introduction of the euro between 2009-2011. The study will outline the EMU criteria - budget and economic policy coordination, the common monetary policy and the single currency. These criteria should be met by countries to become the member state of the Eurozone. This is followed by the introduction of positive and negative impacts of the introduction of the single currency. We used secondary data to assess the implications of euro introduction. The introduction of the single currency had three advantages in Slovakia. The most relevant advantage was the stability – the stable financial environment prevented the devaluation of the currency and had positive impact on the economy. The second important advantage was solving the liquidity problems the countries faced following the economic crisis. As a third benefit was the increase in competitiveness that attracted thousands of foreign investors to Slovakia. The study is focusing on the economic impacts of the introduction of the euro from the perspective of few years.

**Keywords:** Slovakia, EMU, Euro.

### **1 Introduction and Basics about the Economic and Monetary Union of the EU**

The 2004 enlargement of the EU was the largest single expansion of the European Union, integrating countries with different level of economic development. Some of these countries have lagged behind in integration process and have not introduced the single currency yet. Slovakia was successful in introduction of the single currency, since the price of energy, crops and agricultural produce was low. The country experienced surprising effects of the euro introduction e.g. the export fell slightly, the unemployment increased as well as the inflation exceeded the average. The introduction of the single currency had three advantages. The most relevant advantage was the stability – the stable financial environment prevented the devaluation of the currency and had positive impact on the economy. The second important advantage

was solving the liquidity problems the countries faced following the economic crisis. As a third benefit was the increase in competitiveness that attracted thousands of foreign investors to Slovakia.

The Economic and Monetary Union (EMU) was established as an important step towards the integration of national economies. EMU involves the coordination of budgetary and economic policy, the common monetary policy and the single currency. The economic union is represented by 27 states. Some of the countries have reached a higher level of integration and introduced the single currency. These countries form the Eurozone. [5]

The decision to form an Economic and Monetary Union was taken by the European Council in the Dutch city of Maastricht in 1991 and was later enshrined in the Maastricht Treaty. It could be considered as a further step towards the economic integration. The economic integration has many benefits e.g. efficiency enjoyed by the member states individually and the EU as an economic unit as well. [8] The integration is stabilizing the economy, accelerating the growth and increases the employment. These effects have influence on the life within the union. [1,4]

We get the following conclusion about the EMU:

- harmonizing the economic policy of the member states
- harmonizing the fiscal policy of the member states by limiting the national debt and the state deficit
- independent monetary policy controlled by the European Central Bank (ECB) single currency and monetary union. [11]

The development of the economic policy within EMU is shared among the member states and the European institutions. Not only one institution is responsible for development of the economic policy. The key players in EMU are:

- The European Council – defines the general political direction and priorities of the EU
- The Council of Europe (the Council) coordinates the development of the economic policies and decides which member state can introduce the single currency
- The „Euro group“ represents the common interest of Eurozone member states
- The member states which set their national budgets in response to certain limits of deficit and debt, develop their own policies for labour, pension and capital markets
- The European Commission monitors the performance of member states and compliance with the rules
- The European Central Bank (ECB) defines the monetary policy, the main objective is the price stability

The European Parliament – together with the Council and the European Commission exercises the legislation function of the EU, exercises democratic control over the economic governance. [2, 19]

In July 1988 the European Council confirmed the objectives of implementation of the European Monetary Union (EMU). As an initiative, a committee led by Jacques Delors was established (former president of the European Commission) to study what

specific stages lead to the establishment of the union and were asked to make suggestion about it. The committee consisted of the presidents of the national banks of the European Community, Niels Thygesen, professor of Economics from Denmark, Miguel Boyer, the president of Banco Exterior de España. As a result of this cooperation the Delors Report was elaborated, which proposed the establishment of the Economic and Monetary Union in three stages, each phase representing a higher level. [3]

Based on the Delors Report, the European Council determined 1 July 1990 as the beginning of the 1st stage of EMU. They liberalized all the capital movements between the member states and prohibited the monetary financing of public authorities by central banks. The establishment of the European Monetary Institution (EMI) on 1 January 1994 was the beginning of the second phase of the EMU. At the same time, the Presidential Committee ceased to exist. The temporary existence of EMI reflected the state of monetary integration of the Community. The EMI had no responsibility to determine and implement the monetary policy of the EU, this remained the responsibility of the national authorities and was not empowered to implement foreign exchange interventions. The members of the European Council reached a consensus in December 1995 that the European currency planned to be introduced on 1 January 1999 will be the „euro“. They have also determined the transition steps to the single currency.

The third and the final phase of EMU started on 1 January 1999 by fixing the currency rates of the participating 11 member states and introduction of the single monetary policy under the supervision of the ECB. By 1 January, the number of participating member states increased to 12 by the accession of Greece to the EMU. On 1 January 2007, Slovenia became the 13th member of the zone, a year later followed by Cyprus and Malta. Slovakia joined in 2009, Estonia on 1 January 2011. The central banks of these countries automatically became the members of the euro system. [7]

## **2 The Slovak Experience – 2 Years Following the Introduction of the Single Currency**

The introduction of the euro was quite easy, because the price of energy and agricultural produce was low. Slovakia also experienced surprising effects of the new currency e.g. the volume of export declined, the unemployment rate increased, and the inflation was higher than the average.

The Central Bank of Slovakia (NBS) and the Financial Ministry are forecasting 3,5% increase in consumer price, which in contrary to declining trend is still 75% higher than the 2% Eurozone average determined by the European Central Bank (ECB). [20]

Slovakia is a small economy, but this small economy contributes to increase of the EU average (Euro-16 countries). According to the ECB, this area is weakening the stability of the Eurozone. This can be explained by the trend in the Eastern European countries. [9]

## **2.1 Positive Effects of the Introduction of the Euro**

By joining the Eurozone, Slovakia has strengthened its position in workplace creation, long-term potential for economic growth and can control the inflation. Slovakia has become a strong symbol of economic and political progress as well as the integration process.

The introduction of the new currency had three benefits for the country. The most important of these is the existence of stability. They have managed to create a stable financial environment to avoid the depreciation of their currency. The second important step was to find solution for the liquidity problems most of the countries faced due to the economic crisis. The third important benefit was the increase of competitiveness that attracted thousands of investors to Slovakia. [12, 20]

Further positive impact was the abolition of transaction costs and the exchange rate risk. Joining the Eurozone resulted in low base rate and increasing price competition. The flexibility of the labour market has increased since 2004. The number of people working abroad can be estimated approx. 200.000. About 60% of them work in the EU country which is not a member of the Eurozone (about 90.000 people work in Hungary or Czech Republic). An improved transparency will be characteristic for the accession of these countries. [6]

## **2.2 Negative Impacts**

The most important cost of the introduction of the euro is the partial loss of the seigniorage income as the Slovak National Bank has lost its responsibility to issue cash. The national bank loses its independence to determine the exchange rate and interest rate policy. These duties will be exercised by the European Central Bank and the consequences of decisions in which Slovakia is also involved will have an impact on the economy of the Eurozone. The possible worldwide economic shocks can be avoided by the flexible change in price and wage levels.

Following the introduction of the single currency, Slovakia and the corporate sector will face one-time expenses. The costs associated with the introduction of the single currency include the issue and distribution of coins and banknotes, collecting the old coins and banknotes, administration costs, providing information for the public, financing trainings, introducing IT support systems to ensure dual pricing and increased consumer protection. Based on the study of the Slovak National Bank this amount accounts for 0.3% of the Slovak GDP.

The inflation surplus is negative for the Slovak economy in case of consumer or budget overspending or increasing wage outflow. The accession to the EMU resulted in increasing wage outflow into the neighbouring Non-eurozone countries due to lower price level. Hungary and Poland became the favourite destinations of shopping tourism. The danger of shopping tourism is that before the introduction of the single currency, domestic consumption was the main catalyst of the economic growth in Slovakia, while the wage outflow and the decreasing domestic demand deteriorated the growth prospects of the economy. [10, 15]

### 2.3 The Real Impact of the Introduction of the Euro

The impact of the introduction of the euro on the Slovak economy was more favorable than the market analysts forecasted. Before introduction of the single currency the analysts forecasted 7.9% GDP deterioration from 2008 to 2009. In spite of the negative forecasts the values detected were positive as you can see on Table 1 based on own editing of dates by Slovak Statistical Office and Slovak National Bank [13, 20, 18].

**Table 1.** Basic macroeconomic indicators of Slovakia, 2009-2011.

		2009	2010	2011
GDP (current prices)	Bill. EUR	62.8	65.7	69.1
GDP growth (real)	%	-4.9	4.2	3.3
GDP per capita (at current prices)	EUR/capita	11 640	12 140	12 700
Inflation (consumer price index)	%	1.6	1.0	3.9
Rate of unemployment	%	12.0	14.4	13.5
Budget balance	% of GDP	-8.0	-7.7	-4.6
Government debt (at the end of the year)	% of GDP	35.5	41.1	43.3
Balance of current account	% of GDP	-2.5	-2.4	0.06

The structure of the Slovak economy has not changed significantly, which means that the industry has ensured the biggest added value of 32%. The unemployment fell by 0.9% to 13.5% in 2011. This was a positive change since more and more individuals are behind the produced value. The inflation has increased rapidly following the 1% increase in 2010. It reached 3.9% in 2011. The increase of average wage did not follow the price increase, which has increased by 2.2% to 786 EUR. It means 1.6% net increase of real wages.

After the introduction of the euro, the EU funding has increased considerably. 25.02% of the funding was utilized in worth of 11.5 billion euros. Being a member of the Eurozone opened the markets for the Slovak companies that resulted in 17.3% increase of exports to the EU countries and 18% increase of export activities to the OECD members. The export of agricultural produce increased the most (31.3%). (For background information see Table 2 about dates by Slovak National Bank [13]).

**Table 2.** Foreign trade turnover of Slovakia, 2008-2011

		2008	2009	2010	2011
Transaction balance	Bill. EUR	-0.7	0.3	0.5	2.4
Export	Bill. EUR	47.7	40.2	48.3	56.4
Import	Bill. EUR	48.4	39.9	47.8	54.0
Balance of services	Bill. EUR	-0.5	-1.1	-0.7	-0.3
Export	Bill. EUR	5.8	4.3	4.4	48
Import	Bill. EUR	6.3	5.4	5.1	5.1



The development of the Slovak economy depends on the growth of import investments. The capital influx can help the development of the economy. The Slovak conditions became favourable for the foreign investors in 2011. It can be explained by the disappearance of exchange rate costs and the increase of real wages. [18]

Stoličná – Chorvatovičová –Kočíšová analyse the effect and scope which Euro adoption have on level of foreign direct investment in Slovakia. The results of this research with the dates from Slovak National Bank you can see in Table 3. [17]

**Table 3.** Import and export of direct capital investment in Slovakia, 2009-2011

		2009	2010	2011
Foreign direct investment – import	Bill. EUR	-4.376	-0.107	0.846
Foreign direct investment	Bill. EUR	36.469	37.632	n.a.
Capital investment in another country	Bill. EUR	0.651	0.404	0.053
Capital investment stock	Bill. EUR	2.188	2.494	n.a.

The biggest investors from Slovakia during the mentioned period was Matador in fields of vehicle industry, Slovenský investičný holding (Slovak Investment Holding) focused on property development, Holcim Slovensko in fields of cement, gravel and concrete production, J&T on property development and Penta focused on venture capital/food industry.

### 3 Conclusion

The development of the Slovak economy during the period 2004-2008 was intense. The reform packages made the economy characterized by high potential more transparent and attractive for foreign investors. The influx of foreign investment resulted in economic development and record growth was detected in 2006 and 2007. The disadvantage is that the regional and social disparities have not diminished due to enormous economic growth.

The growth in the past few years has stabilized the economy. The economic policy was able to cope with the increasing unemployment, budget deficit and national debt without introducing serious restrictions. The development of regions inhabited by Hungarians is determined by new opportunities due to the accession to the EU and the Schengen area.

The currencies of the neighbouring countries were devalued as a result of the economic crisis. The regions of Southern Slovakia got into controversial situation with the regions beyond the country border that seemed to label off with the increased shopping tourism until the strengthening of the Hungarian currency. The introduction of the single currency results in benefits and real economic costs both in short and long term.

Slovakia might be an example for Hungary and the neighbouring member states, what kind of tasks are necessary to master before introduction of the euro. The

introduction of the flat-rate tax system in Slovakia contributed to acceleration of capital inflow and economic development. The private and pension funds prove to be strong, but the new government is planning radical restructuring of these institutions, which might have a negative impact on pension funds. The new government forecasted serious changes in healthcare, public administration and education. There was no other solution, because the overspending of Fico government has visible negative effects. The introduction of the single currency has practically gone smoothly. Slovakia has joined the Eurozone as early as possible, which promises shelter during the economic crisis and can minimize the risk of exchange-rate speculations.

**Acknowledgements.** The study was implemented with support from Pallas Athéné Domus Educationis Foundation.



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## References

1. Az európai gazdasági és monetáris unió kialakulásának és működésének intézményi és jogi vonatkozású kérdései. <https://www.palyazat.gov.hu/download.php?objectId=463>, last accessed 2018/10/05.
2. European Central Bank, <https://www.ecb.europa.eu/ecb/history/emu/html/index.en.html>, last accessed 2018/10/05.
3. European Comission, [https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/economic-and-monetary-union/what-economic-and-monetary-union-emu\\_en](https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/economic-and-monetary-union/what-economic-and-monetary-union-emu_en), last accessed 2018/10/05.
4. European Comision, [http://europa.eu/rapid/press-release\\_IP-12-1272\\_en.htm](http://europa.eu/rapid/press-release_IP-12-1272_en.htm), last accessed 2018/10/06.
5. European Union, <https://publications.europa.eu/en/publication-detail/-/publication/20691fde-ca17-4c58-bb7a-6aeb23024a84>, last accessed 2018/10/05
6. Gál, Z.: Az euró bevezetése Szlovákiában: Előzménye, előnyök és rizikók. Az Elemző 4(2), 57-86 (2008).
7. Grauwe, D.P.: Economics of Monetary Union. 11th edn. Oxford University Press, Oxford (UK), (2016).
8. Hedija, V.: The suitability of adopting the Euro in the new European Union member states: Application of the theory of the optimum currency areas. Ekonomický časopis 61(3), 235-250 (2013).

9. Kotlebová, J., Chovancová, B.: Medzinárodné finančné centrá: zmeny v globálnej finančnej architecture. 1st edn. Iura Edition, Bratislava (2010).
10. Lacina, L., Rozmahel, P. et al.: Euro: ano/ne?, 1st edn. ALFA, Praha (2010).
11. Larch, M., Wanner, J., Yotov, Y.V.: Bi- and Unilateral trade effects of joining the Euro. *Economic Letters*, 171(C), 230-234 (2018). DOI: 10.1016/j.econlet.2018.08.001.
12. Národná banka Slovenska: Analýza dopadov zavedenia eura na slovenský finančný trh. [https://www.nbs.sk/\\_img/Documents/\\_Dohlad/ORM/Analzy/ANALEUR.PDF](https://www.nbs.sk/_img/Documents/_Dohlad/ORM/Analzy/ANALEUR.PDF), last accessed 2018/10/12.
13. Národná banka Slovenska, <https://www.nbs.sk/sk/menova-politika/makroekonomicka-databaza/makroekonomicke-ukazovatele-graf>, last accessed 2018/10/12.
14. Národná banka Slovenska: Vplyv zavedenia eura na slovenské hospodárstvo, [http://www.nbs.sk/\\_img/Documents/PUBLIK/06\\_kol1.pdf](http://www.nbs.sk/_img/Documents/PUBLIK/06_kol1.pdf), last accessed 2018/10/11
15. Národné účty - Štatistický úrad Slovenskej republiky, [https://slovak.statistics.sk/wps/portal/ext/themes/macroeconomic/accounts/indicators!/ut/p/z1/pZLNDoIwEISfxSfoAOXvWFBKDeGvItiL4WRIFD0Yn1-U6MGEYsLeNplvdzK7RJGGqL59dKf231379jz0B-UcC1d4QWAweLYLiFRWwF5CCpD6R5CWG4gdy3m5pQaoTZSGx4cPOYupmwBewm0IFlelX1gWmKXlv\\_sxUQz\\_8VOCzNHys7w0O8fxut5bizzPxhcXlvRvybemqi3RHfBuRiKa\\_KVwdwXjYJI5ibzKQ\\_XZRYNXxiankwcEzDI7VKN1aATHVs9AfN57zs!/dz/d5/L2dJQSEvUUt3QS80TmxFL1o2X1E3SThCQjFBMDg1NzAwSU5TVTAwVIMwU0sy/](https://slovak.statistics.sk/wps/portal/ext/themes/macroeconomic/accounts/indicators!/ut/p/z1/pZLNDoIwEISfxSfoAOXvWFBKDeGvItiL4WRIFD0Yn1-U6MGEYsLeNplvdzK7RJGGqL59dKf231379jz0B-UcC1d4QWAweLYLiFRWwF5CCpD6R5CWG4gdy3m5pQaoTZSGx4cPOYupmwBewm0IFlelX1gWmKXlv_sxUQz_8VOCzNHys7w0O8fxut5bizzPxhcXlvRvybemqi3RHfBuRiKa_KVwdwXjYJI5ibzKQ_XZRYNXxiankwcEzDI7VKN1aATHVs9AfN57zs!/dz/d5/L2dJQSEvUUt3QS80TmxFL1o2X1E3SThCQjFBMDg1NzAwSU5TVTAwVIMwU0sy/), last accessed 2018/10/10.
16. Siranová, M., Kotlebová, J.: Stimulating economic recovery through euro area growth poles: call for more direct unconventional monetary policy measure? *Equilibrium – quarterly journal of economics and economic policy* 12(4), 633-653 (2017). DOI: 10.24136/eq.v12i4.33.
17. Stoličná, Z., Chorvatovičová, L., Kočišová, L.: Level of Foreign Direct Investment in Slovakia in Relation to Euro Adoption and Comparison to Czech Republic. In: Soliman, K.S. (ed.) *Vision 2020: Sustainable Economic Development, Innovation Management, and Global Growth*, pp. 4894-4902, International Business Information Management Association (IBIMA), Norristown (2017).
18. Širá, E., Dubravská, M.: Vývoj priamych zahraničných investícií vo vybraných regiónoch – Development of foreign direct investments in selected countries. In Klímová, V., Žítek, V. (eds.), *17th International Colloquium on Regional Sciences*, pp 157-163. Masarykova univerzita, Hustopeče (2017).
19. Výhody eura sú nespochybniteľné, ale: <https://www.jet.sk/news/view/vyhody-eura-su-nespochybnitelne-ale>, last accessed 2018/10/12.
20. Zahraničný obchod - Štatistický úrad Slovenskej republiky, [https://slovak.statistics.sk/wps/portal/ext/themes/macroeconomic/trade/indicators!/ut/p/z1/pZPLboMwEEW\\_JV\\_gCzav5YQW4wTlgUtCvIlyVUgtzSLK9wf6UKVKjCtldpbuuXfsGQsnWuGG7ta\\_dtf-Y-jexvPJxed9YtLIMiCkUQKYjW2AgwWVUhZ\\_CDb1M8wL7XS9UgFUJNw8b4FvPtdUqqQC0kpHMFQ2dbaXEiQ5\\_jcfM0X4Hz\\_X4DZm-7fKw4PNn-x5Xgcsvw49\\_Nggxxt4eIPh8kfBI-8\\_CRw\\_3qNwnxJug3wejr3kNAPfFn8JCrsLKVM6f6q3xfgL8jC1VRwCPodYist781MtetMbWizujLpecg!/dz/d5/L2dJQSEvUUt3QS80TmxFL1o2X1E3SThCQjFBMDg1NzAwSU5TVTAwVIMwQVA1/](https://slovak.statistics.sk/wps/portal/ext/themes/macroeconomic/trade/indicators!/ut/p/z1/pZPLboMwEEW_JV_gCzav5YQW4wTlgUtCvIlyVUgtzSLK9wf6UKVKjCtldpbuuXfsGQsnWuGG7ta_dtf-Y-jexvPJxed9YtLIMiCkUQKYjW2AgwWVUhZ_CDb1M8wL7XS9UgFUJNw8b4FvPtdUqqQC0kpHMFQ2dbaXEiQ5_jcfM0X4Hz_X4DZm-7fKw4PNn-x5Xgcsvw49_Nggxxt4eIPh8kfBI-8_CRw_3qNwnxJug3wejr3kNAPfFn8JCrsLKVM6f6q3xfgL8jC1VRwCPodYist781MtetMbWizujLpecg!/dz/d5/L2dJQSEvUUt3QS80TmxFL1o2X1E3SThCQjFBMDg1NzAwSU5TVTAwVIMwQVA1/), last accessed 2018/10/10.

## Smart Specializations in Poland and the Czech Republic

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**Abstract.** The aim of the article is to present the assumptions and requirements and to analyse the strategy of building intelligent specializations in Polish and Czech regions. Smart specialization is a new paradigm of building a competitive advantage of European regions, exposing the territorial character of development. It is a response to the underdevelopment of the R & D sector, inefficiencies in public spending, and the declining innovation of the European economy, resulting in deepening detachment from global economic powers. It can be concluded that the basis of smart specializations is the potential of regions, community involvement and the use of their knowledge and public support. Smart specialization is at the same time a new paradigm shaping the regional innovation policy, striving to eliminate the existing barriers and failures in building the innovative capacity of the regions. The article shows the ideas of this concept and exposes its new approach. The authors undertook to present the experiences and dilemmas of Poland and the Czech Republic in creating smart regional development.

**Keywords:** Smart Specialization, National Specializations, Innovation.

### 1 Introduction

The strategies implemented by the European Union are currently focused on innovation. The reason for changes in the approach to the development of the regions belonging to the Community is the productivity, innovation and economic growth gap growing over the last two decades. It is visible especially in the sphere of research and development activity as well as in the sectors of high technology and techniques. The growing gap between the countries of the European Union and the United States, Japan and China in terms of competitiveness and innovation of the economy as well as declining dynamics of economic growth have become the basis for radical decisions regarding strengthening Europe's position in the global economy. The answer to these challenges was the development of the Europe 2020 strategy, which replaced the Lisbon Strategy introduced in 2000 [12].

The concept of innovation has many definitions in the literature on the subject. Analysing them, one can draw the conclusion that contemporarily this concept has significantly expanded. It abandoned the perception of innovation as a single event in favour of a set of phenomena and events that create new products, patterns, technologies and services [9]. Innovations are now identified with systematically

implemented activities that aim at increasing the efficiency of the enterprise, by using new processes, technologies and materials, as well as creating new business vision and complex strategies [8].

The Europe 2020 strategy is focused on innovation and applies to smart, sustainable and socially inclusive growth. The creation of a new strategy has also become necessary due to significant problems in the countries of the Community, i.e. economic crisis, rising unemployment, social exclusion, aging of the population, etc. [7] Three mutually reinforcing priorities constitute the basis of the new strategy [1]:

- smart development - development of a knowledge and innovation - based economy,
- sustainable development - supporting a resource-efficient economy, more environment-friendly and more competitive,
- inclusive growth - supporting a more resource efficient, more environmentally friendly and more competitive economy.

The priorities mentioned above indicate that the concept of creating smart specializations results from the criticism of the current innovation policy of the Community countries [17].

In the new concept of smart development, attention was drawn to the concept of smart specialization created by D. Foray, J. Goddard, X.G. Beldarraine et al. and defined as "economic areas highlighted by member states and regions, based on scientific and R & D potential developed in the region, as well as other regional development potentials, focused on a small number of priorities, based on objective data and evidence." [2] The grounds for development based on intelligent specializations are constituted by the place-based approach. It means that for development it is important to take into account the geographical location regarding institutional, cultural and social characteristics. In the policy conducted at the local level, it focuses on the use of knowledge regarding the specificity of the place and the role of the institution. Such an approach has now become the basis of regional development policy and European Union cohesion policy [13].

„The smart specialization strategy means national or regional innovation strategies setting priorities to gain a competitive advantage by developing and combining their strengths in research and innovation with business needs in order to exploit emerging opportunities and market development in a coherent way while avoiding duplication and fragmentation efforts" [14]. As noted by Wiatrak, "the national dimension of specialization is also regional in nature, because it refers to a specific country, and thus also an area that generally has specific characteristics in relation to others" [15]. And hence, the national dimension has a significant impact on the regions and their economy.

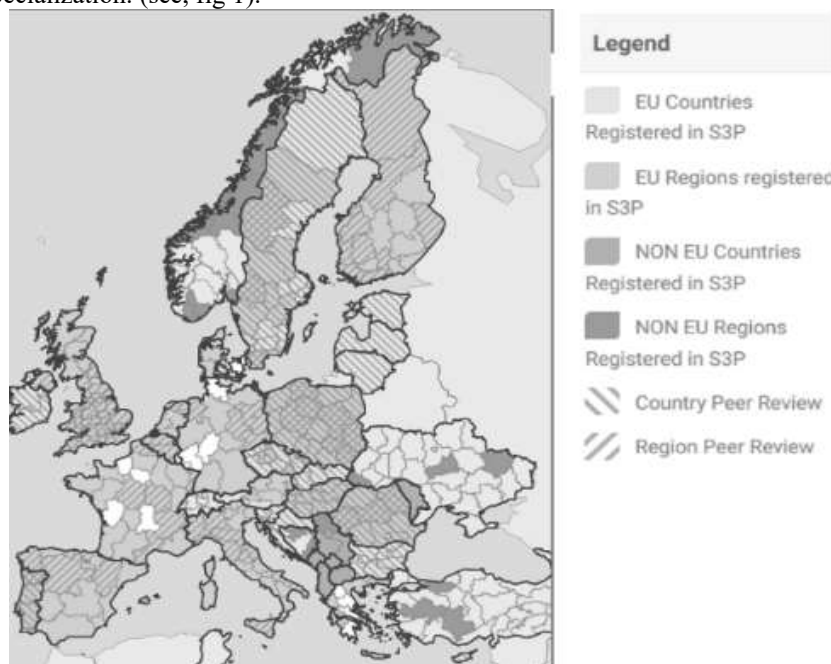
The aim of this publication is to present the general concept of smart specializations with particular consideration of the specificity of two neighbouring countries, i.e. Poland and the Czech Republic. The research method used in this publication is the analysis of secondary materials, ie.: regional innovation strategies, regional development strategies and regional operational programs, as well as the analysis of the 3S Platform, the literature on the subject and the EU program documents and expert opinions.

## 2 European Union Policy on Smart Specializations and the Approach of Polish and Czech Regions

In order to help the countries and regions of the Community to develop, implement and review their research and innovation strategies for smart specialization (RIS3), the European Union created the S3 Platform as part of the implementation of the adopted Europe 2020 strategy. The platform was created in June 2011 and is managed by a team of the Joint Research Centre (JRC-IPTS) in Seville.

The task of the Platform is to provide information, methodology and specialist knowledge to national and regional decision-makers. It is also intended to encourage mutual learning, national cooperation and academic debates around the concept of smart specialization [4].

Currently, participants / members of the Platform are 18 countries and 177 regions from the European Union as well as 6 countries and 16 regions from outside the Community. Not all countries and regions have already identified areas of smart specialization. (see, fig 1).



**Fig. 1.** Map of countries and regions registered in smart specialization platform [4].

Among the countries registered on the 3S Platform there are also Poland and the Czech Republic, wherein the framework of Regional Smart Specializations includes all sixteen Polish voivodeships, while in the Czech Republic only 4 out of 13 local governments were included.

It is possible to apply for funds to finance the so-called Smart Specialization both within the country (National Smart Specializations - NSS) and within the regions

(Regional Smart Specializations - RSS). National Smart Specializations are industries the development of which will ensure:

- creating innovative socio-economic solutions,
- increasing the added value of the economy,
- raising its competitiveness on the international arena.

Regional smart specializations are areas of economy or science identified as priority and intended for development by each of the regions. Investing in precisely defined areas allows for optimization of activities for economic development. The focus of investment activities in specific areas of the economy also allows better use of resources and financial resources [5].

However, while applying for funding, the regions need to take into account that only the projects that fall under the smart specialization will be covered by financial support. Therefore, it is important for the submitted projects to be implemented in areas compatible with smart specializations.

## 2.1 Smart Specializations Implemented within National (KIS) and Regional (RIS 3) Innovation Strategies in Poland

In Poland, as part of both national and regional programs concerning smart specializations, enterprises and other entities may apply for subsidies from 5 thematic areas, within which 17 smart specializations have been designated. [6], (table 1).

**Table 1.** Thematic sections and specializations assigned to them, implemented as part of national specializations in Poland [6].

Fields	National Smart Specializations
Healthy society	1. healthy society
Agri-food bioeconomy	2. innovative technologies, processes and products of the agri-food and forest-wood sectors
	3. biotechnological and chemical processes, bioproducts and the products of specialized chemistry and environmental engineering
Sustainable energy	4. high-efficiency, low-emission integrated systems for generation, storage, transmission and distribution of energy
	5. smart and energy-saving construction
	6. environmentally friendly transport solutions
Natural resources and waste management	7. modern technologies of acquiring, processing and using natural resources as well as producing their substitutes
	8. minimization of waste generation, including non-recyclable waste as well as material and energy use of waste (recycling and other recovery methods)
	9. innovative solutions and technologies in water and sewage management
	10. multifunctional materials and composites with advanced properties, including nanoprocesses and nanoproducts
Innovative technologies and industrial processes	11. sensors (including biosensors) and smart sensor networks
	12. intelligent networks and information and communication and geoinformation technologies
	13. printed, organic and flexible electronics

14. automation and robotics of technological processes
  15. photonics
  16. intelligent creative technologies
  17. innovative marine technologies in the field of specialized vessels, marine and offshore constructions and logistics based on sea and inland transport
- 

The national smart specializations presented in the table are not, however, to a large extent consistent with regional specializations, which can significantly influence the consistency of objectives pursued by individual entities.

Another important issue is the fact that work on innovation strategies in various regions of Poland, where the areas of smart regional specializations were indicated, were conducted at different times and using different methodological approaches. The reason for these inaccuracies was the fact that in many provinces regional innovation strategies were developed much earlier than national strategies, which significantly influenced the final selection of domains of specialization [16]. At the same time, during the identification of the areas of specialization, there were no clear guidelines and arrangements regarding cohesion policy and financing the development of regional specializations. This in turn generated uncertainty of the regions and a broad approach to determining them [11].

Another problem is sceptical, but sometimes justified, approach of some regions and industries in Poland to these solutions. They are afraid of unequal treatment, for example during the distribution of the funds available for this purpose. This is evident, for example, in the documents programming the development of the European Union for the years 2014-2020. According to this document, countries (regions) that want to use EU funds for investments supporting research development and innovation implementation are being threatened not get them unless they prepare the Regional Strategy of Research and Innovation for smart specialization.

In Poland, all voivodships have identified their specializations, indicating from 3 to 8 areas. Smart areas of specialization, however, have been defined by self-governments in various perspectives: sectoral, industrial and horizontal, which significantly impedes their compilation and classification. There are also sometimes differences in the number of areas identified in regional documents with those shown on Platform S3. The reason is the fact that they are open and each voivodeship can update them on an ongoing basis. In addition, not all specializations indicated by the regions have found a reference in the priority areas of the European Union, which means that some projects will not receive co-financing (see, table 2).

The most frequently indicated regional specialization in Poland are widely understood ICT and multimedia technologies, determined as the area of smart specializations by as many as 12 provinces. Medicine and health tourism (10 provinces) and healthy food (9 voivodships) are also frequently referred to. In addition, five areas were identified only in individual voivodships, thus highlighting the uniqueness of regional resources, these were: business services defined in Mazowieckie, spatial mobility and mining industry – in Dolnośląskie, aviation and cosmonautics – in Podkarpackie, water economics – in Warmińsko-Mazurskie and the production of so-called plastics – in Kujawsko-Pomorskie voivodeship.

While analysing the above areas, it can be observed that the choice of domains of specialization by regions is very broad and general. In addition, many areas do not



meet the theoretical requirements of the concept of smart specialization. The basic problems related to this approach listed by Nowakowska include the weakness of the bottom-up and pro-entrepreneurial approach to selecting the domain of specialization, the underdeveloped scientific base and linking the domain of specialization with the R & D sector, poor experience of cooperation within the area of specialization, unconfirmed by economic successes [11].

While analysing the above areas, it can be observed that the choice of domains of specialization by regions is very broad and general. In addition, many areas do not meet the theoretical requirements of the concept of smart specialization. The basic problems related to this approach listed by Nowakowska include the weakness of the bottom-up and pro-entrepreneurial approach to selecting the domain of specialization, the underdeveloped scientific base and linking the domain of specialization with the R & D sector, poor experience of cooperation within the area of specialization, unconfirmed by economic successes [11].

**Table 2.** Areas of smart specializations in Polish regions [3].

Specification	ICT/multimedia	Bio-economy	Organic food	Medicine/health tourism	Machine and metal industry	Energy (including RES)	Chemistry	Creative industries	Construction	Logistics/water and land engineering	High quality of life	Wood and furniture industry	Textile industry and design	Other
Dolnośląskie	x		x	x	x		x							x
Kujawsko-Pomorskie	x	x	x	x	x			x		x				x
Lubelskie	x	x		x		x								
Lubuskie		x		x	x			x				x		
Łódzkie	x		x	x		x			x				x	
Małopolskie	x				x	x	x	x			x			
Mazowieckie	x		x								x			x
Opolskie			x		x	x			x			x		
Podkarpackie	x									x	x			x
Podlaskie		x	x	x	x									
Pomorskie	x	x		x		x				x				
Śląskie	x	x		x		x		x						
Świętokrzyskie	x		x	x	x	x			x					
Warmińsko-Mazurskie			x									x		x
Wielkopolskie	x	x	x					x		x		x	x	
Zachodniopomorskie	x	x		x	x			x		x				

Nowakowska points also to the key problems that emerged during the building of smart specializations and positive aspects that, if noticed by local governments, will

be an important step towards building the innovative capacities of Polish regions. (see, table 3).

**Table 3.** Positive and negative aspects of the process of building smart specializations in Polish regions [11]

Negative aspects	Positive aspects
<ul style="list-style-type: none"> <li>• lack of coherence in the areas of specialization presented in various strategic regional documents, i.e. incorrect chronology of document preparation;</li> <li>• a different methodology of creating innovation strategies and the substantive scope, which resulted in inconsistency and modification of the recommendations of the authors of the concept as to the ways of selecting and implementing innovation strategies;</li> <li>• selecting too many areas of smart specializations, poor selection and focusing on strategic spheres that can create regional competitive capabilities in the international dimension;</li> <li>• losing the international / global perspective of selecting areas of specialization;</li> <li>• specialization domains indicated in many regions do not have international and global competitive abilities;</li> <li>• fragmentation of support addressed to the building of smart specializations under public policies and poorly defined preferences and fuzzy criteria for selecting actions and entities (recipients of support);</li> <li>• unsatisfactorily sophisticated and creative policy of building innovative capacities of regions - poorly identified real needs of regional entities with the proposal of universal sets of activities;</li> <li>• budding system of monitoring and evaluation of smart specializations in most regions, weakness of existing system and institutional solutions in this area.</li> </ul>	<ul style="list-style-type: none"> <li>• increased awareness and maturity of regional authorities to build innovative capacities of regions - in regional policy we observe a strong orientation of actions and financial resources for strengthening innovation processes;</li> <li>• good socialization of the process of selecting smart specializations - numerous consultations, workshops, and seminars with various groups of regional actors (mainly entrepreneurs, scientists and business environment institutions);</li> <li>• significant improvement of the knowledge base on regional innovation processes - the process of building innovation strategies was accompanied by a growing number of analyzes, evaluations and expert opinions, which significantly enriched knowledge about regional potentials and mechanisms;</li> <li>• greater methodological maturity in building innovation strategies, records in most strategies are more specific, strategies go down to lower levels of detail, are well-equipped with indicators.</li> </ul>

## 2.2 Smart Specializations Implemented under Regional Innovation Strategies (RIS3) in the Czech Republic

As well as in Poland, also in the Czech Republic exists National Innovative Strategy, where this strategy defines four priority axes. Every axis is consequently divided into

several subcategories, more or less connected with smart specializations. These axes are as follows [10]:

- Excellent research
  - Effective using of public resources on research and development
  - Top research infrastructures
  - European research area – the way to excellency in research
- The development of cooperation for knowledge transfer between business and academic sectors
  - The improvement of inner conditions and overall readiness of academic institutions for cooperation with companies and for commercialization of research outputs
  - The support of cooperation between companies and R&D institutions
  - The increase of quality and development of new services of support innovative infrastructure
- Innovative entrepreneurship
  - Services for innovative entrepreneurship
  - Financial instruments and development of risk capital market
  - Investment incentives, care for investors, and direct marketing
  - Internationalization
  - Quality foresight – source of strategic information for entrepreneurship and innovation
  - Public sector – source of innovative demand and creator of regulation
- Human resources – main carriers of new ideas and initiators of changes
  - Reform of higher education
  - The development of lifelong learning
  - Changes of education content – creativity, enterprise, and key competences
  - Development of quality employees on national level and facilitation of enter, stay, and employment of quality foreigners

However, also in the Czech Republic do not regional strategies comply fully with national one. Moreover, regional strategies usually exist only in form of web page; there is no generally available document with detail description. On the other hand, some of usually supported areas are for example Human resources, Cooperation and transfer of technologies, Business development, etc.

### **3 Discussion**

As was already mentioned, the strategies implemented by the European Union are currently focused on innovation, because of the growing gap over the last two decades between the countries of the European Union and the United States, Japan and China in terms of competitiveness and innovation of the economy. It is visible especially in the sphere of research and development activity as well as in the sectors of high

technology and techniques. The answer to these challenges was the development of the Europe 2020 strategy, which replaced the Lisbon Strategy introduced in 2000 [1].

However, the problem with this strategy can be seen in the consistence of national strategies with the European aim, or with the consistence of regional strategies in every country with national. This inconsistency can be seen in Poland, as well as in the Czech Republic. In both mentioned countries can be found both the national innovation strategy and regional innovation strategies, but the content of regional strategies usually does not comply with the national one at all, or only in small measure. Moreover, another problem, which sometimes occurs, is about the content of each regional strategy. These strategies are sometimes very similar or almost the same, the differences are only insignificant or symbolic. The reasons of this similarity can be, of course, the similar conditions in every region, but more likely, one strategy has been prepared as a copy of different one with only small improvements.

That means that some of these strategies have been probably prepared only for the fulfillment of the condition about the existence of such strategy, where it is not corresponding with the reality and it is not even trying to solve the European problem. This approach is not extraordinary, but that means that good intention of European representatives cannot be applied properly because of lack of willingness from the regional representatives. The question is whether this lack of willingness is really the problem of local representatives, or it is just reaction on the growing requirements in terms of bureaucracy from the EU. The possible explanation can also be that the local representatives are not seeing the meaning in preparing of different strategies, where the final impact of such strategies is very low or none at all. If this assumption is true, it is quite understandable that the local representatives are trying to minimize the cost (both financial and time) on preparing of such strategies.

## **4 Conclusion**

The concept of smart specialization presented by the European Union departs from the one used so far in regional policy. It consisted in supporting many different activities, which certainly did not support the building of critical mass and limited the effectiveness of implemented innovations. The assumptions of the concept of smart specializations show that their main goal is to improve the efficiency of innovation processes in the European Union countries. It should be added, however, that the concept proposed by D. Foray and co-authors is nothing new as these issues were already taken up in economic theories presented by representatives of various trends.

On the one hand, a new regional policy based on smart specializations is an opportunity for regions, including enterprises while on the other there are indications that the implementation of the concept of smart specializations will result in an even greater gap in the level of economic development between the richest and least prosperous regions.

In the case of Poland, this is visible, inter alia, in the lack of coherence between national and regional areas of smart specializations, which may significantly reduce the chances of development of a given area as its development will be based only on resources available to the regions, and it will certainly significantly weaken

opportunities to build an international competitive position, which are defined as priorities in the Strategy's assumptions.

Concerns of the regions are also raised by the way in which funds are allocated for specializations. They result from the previous experiences of the representatives of local governments, in which the most innovative regions had an advantage in competing for EU funds resulting, for example, from experience in submitting applications. There is also a fear that the increase in innovation expenditure will actually affect the region's economic growth.

## References

1. European Commission: Communication from the Commission. EUROPE 2020. A strategy for smart, sustainable and inclusive growth, Brussels, 3(3), COM 2020 final (2010).
2. Foray, D., Goddard, J., Beldarrain X.G., et al.: Guide to Research and Innovation Strategies for Smart Specialisations (RIS 3), European Commission, pp. 8 (2012).
3. <http://eurofundusze.pl/czym-sa-inteligentne-specjalizacje/> last accessed 2018/10/17.
4. <http://s3platform.jrc.ec.europa.eu/home>, last accessed 2018/10/17.
5. <http://www.rpo.malopolska.pl/o-programie/poznaj-zasady-dzialania-programu/inteligentne-specjalizacje>, last accessed 2018/10/17.
6. <https://krajoweinteligentnespecjalizacje.pl/> last accessed 2018/10/17.
7. Kowalska, A.: Innowacyjność polskiej gastronomii i jej uwarunkowania. Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław (2018).
8. Kraśnicka, T., Ingram, T. (red.): Innowacyjność przedsiębiorstw – koncepcje, uwarunkowania i pomiar. Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, Katowice (2014).
9. Krzyżanowska, K.: Ekonomiczno-społeczne uwarunkowania innowacji w zespółowym działaniu w rolnictwie. Wydawnictwo SGGW, Warszawa (2016).
10. Národní inovační strategie České republiky; <https://www.databaze-strategie.cz/cz/mpo/strategie/narodni-inovacni-strategie-ceske-republiky?typ=download>; last accessed 2018/28/10.
11. Nowakowska, A.: Budowanie inteligentnych specjalizacji – doświadczenia i dylematy polskich regionów. *Studia Prawno-Ekonomiczne*, 97, pp. 325–340, (2015).
12. Strategia Europa 2020; [www.ec.europa.eu/eu2020/pdf/1\\_PL\\_ACT\\_part1\\_v1.pdf](http://www.ec.europa.eu/eu2020/pdf/1_PL_ACT_part1_v1.pdf); last accessed 2018/10/17.
13. Szostak, E.: Inteligentne specjalizacje w rozwoju regionu, w: *Studia Ekonomiczne, Uniwersytet Ekonomiczny w Katowicach*, 209, pp. 209-218(2015).
14. Unia Europejska. Inteligentna specjalizacja: tworzenie sieci doskonałości na rzecz należytej prowadzonej polityki spójności. Rezolucja Parlamentu Europejskiego z dnia 14 stycznia 2014 r. (2013/2094(INI)). *Dz. Urz. UE* 2016/C 482/01 -2016/12/23.
15. Wiatrak, A.P.: Istota i cele krajowych i regionalnych inteligentnych specjalizacji w sektorze rolnym, *Roczniki Naukowe Stowarzyszenia Ekonomistów Rolnictwa i Agrobiznesu*, 19(5), pp. 210-216 (2017) doi: 10.5604/01.3001.0010.6239
16. Wojarska, M: Identyfikacja regionalnych smart specialisation – diagnoza i ocena, w: W.M. Gaczek (red.), *Dynamika, cele i polityka zintegrowanego rozwoju regionów*, Publishing Bogucki Wydawnictwo Naukowe, Poznań (2013).

17. Wolniak, R., Inteligentne specjalizacje w województwie śląskim. Systemy wspomagania w inżynierii produkcji. Metody i narzędzia inżynierii produkcji dla rozwoju inteligentnych specjalizacji 4(16) (2016).

## Improving Supply Chain Management in an Integrated Planning Centre

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**Abstract.** Currently supply chain management in a large company is an extremely complex undertaking. In order to remain competitive in global markets, companies are improving their product flow management processes, and the emphasis on streamlining logistics activities in order to reduce time and minimize supply chain costs is crucial in this area. Customers want to receive the ordered goods as soon as possible, so the flexibility of supply chains and their responsiveness to market demand should be as high as possible. The article analyses an integrated planning centre of one of the leading food producers. The planning centre manages the supply chain in the "End2End" model, i.e. from sending the expected demand for components needed for production, through production planning, to the delivery of the final product to the market for the customer. At the same time the centre manages not only the parent company's entities, but also cooperates with partners by integrating individual entities in the supply chain. The proposed improvements will pertain to the broadly understood subject of the flow of goods and information through ERP systems. The area of improvements included management processes in the supply chain of a manufacturing company, in order to improve its internal processes and increase the efficiency of operations.

**Keywords:** Supply Chain, Management Processes, Logistics Centre, End2End, KPI.

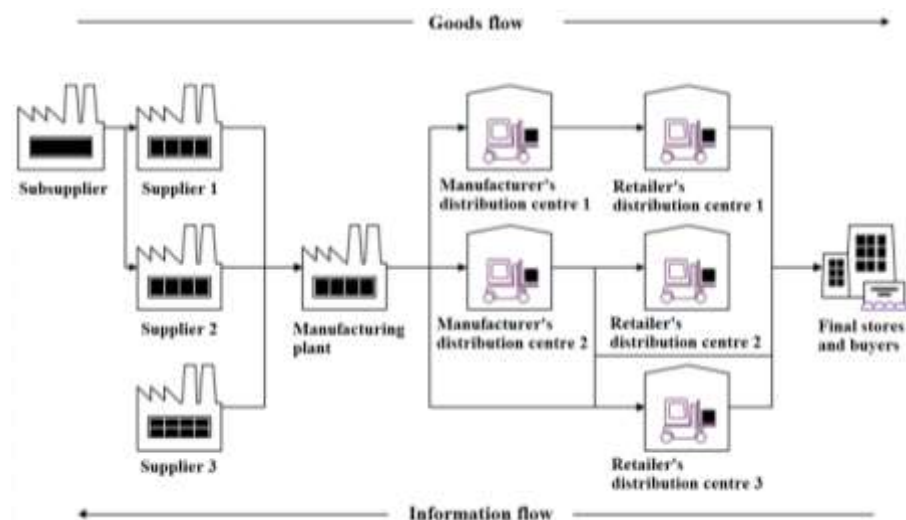
### 1 Introduction

The economic growth of a given country, and thus its competitiveness, depends on technological progress and implemented innovations. Acceleration of its growth is possible due to the increase in the dynamics of efficiency which is ensured by investments in research and development as well as innovation [6]. High competitiveness and globalization on the markets force companies to create different logistics strategies and at the same time to adapt the chain and structure network to the given area of activity. However, the way logistics networks are built is not always the same, e.g. a different logistics strategy and supply chain management model will be adopted by a local company that produces specialized mechanical components tailored

to individual customers, and a completely different flow management concept will have a global company that produces fast-moving, unified goods for a large number of first or second order customers. Choosing the right strategy, modelling, integration and supply chain control is one of the challenges companies face.

### 1.1 Definitions and Terms

Different definitions of the supply chain can be found in the available literature, but given that in logistics it is increasingly important to integrate and cooperate with each other and to include a holistic aspect of the product, the best definition seems to be this one: "A supply chain is a network of partners who collectively convert a basic commodity (upstream) into a finished product (downstream) that is valued by end-customers, and who manage returns at each stage" [3]. The supply chain model for a given product is shown in Figure 1.



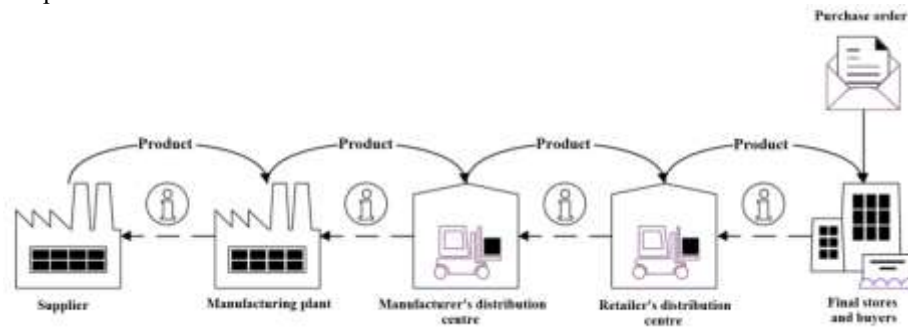
**Fig. 1.** Supply chain model [3, 9].

Figure 1 shows two main streams running from the source of the chain to the final purchaser. These are the flows of goods and information. These are the two basic flows in each logistical process. The supreme goal of logistics is to maintain the continuity of this flow, and both the flow of information and goods should be controlled so that it is not subject to any disruption or downtime.

For better illustration of the integration of the supply chain, Figure 2 shows the model of the supply chain functioning on the basis of a single signal from the purchaser, which triggers an avalanche of information and processes to the entities assigned to it. The signal with a new order is converted for each unit and then the demand information



is passed down (towards the source of the chain). Then the good flows back to the final recipient.



**Fig. 2.** Diagram of the integrated supply chain [3, 9].

This chain is highly integrated above the organisational divisions of individual entities and requires the coupling of individual control systems of cooperating companies. Supply chains are complex systems, dynamic, dispersed and open; is a metastructure [4]. We can distinguish the following approaches to the creation of supply chain strategies [5]:

- evolutionary,
- classic,
- adjustment,
- system.

The main reason for the concept of ECR (Effective Customer Response) was the willingness to combine supply chain management with demand forecasting. The concept was developed as a supply chain management system for companies trading in FMCG (Fast Moving Consumer Goods). The main undertakings on which ECR systems focus include the following tasks:

- category management - the main task of category management is to prevent shortages of goods at the buyer and closer correlation with customers, in order to determine the best possible diversity and offer at the appropriate level of inventory. Additional tasks of category management also include jointly determining the implementation of promotions and new products, removing unprofitable products from the markets or attempting to adjust the prices of products to specific market situations,
- continuous inventory recovery management - in order to manage total inventory more efficiently throughout the supply chain, these activities include material planning, production and distribution through a “pull” mechanism,
- supporting technologies management of - this system is aimed at receiving, processing and making available the most precise information in supply chains, such as: expected demand, consumption and sales, value of product inventories and their realization status. RFID (Radio Frequency Identification) systems are important.

They allow to monitor the levels of assets on an ongoing basis and obtain a range of information on where a given product is located.

## **1.2 Importance of Planning Systems in the Supply Chain**

Supply chain planning systems greatly facilitate decision making and accelerate the monotonous and complex, large-scale calculations that would be required for demand, production or distribution planning. Modern systems, which are based on multi-level planning models, enable full integration of the supply chain and provide complete solutions available to companies, often offering functionality extensions beyond the supply chain management system. Additionally, they perform the function of cloud computing, thanks to which access to them is possible from any place in the world, connected to a common cloud via the Internet [8]. Manufacturing Planning and Control (MPC) systems are designed to meet customer requirements at a higher level by proposing solutions that will streamline logistics processes in the company. In addition, taking into account recent considerations of supply chain theorists, modern systems should not only respond to the current needs of the company, but should also be able to develop in the future in case of technical breakthroughs in supply chain technology or improvement of business processes to a certain level of excellence [11].

The use of such complex systems as ERP (Enterprise Resource Planning) systems for planning in the supply chain requires high accuracy and awareness of the impact of the execution of tasks by employees [4, 10]. It is important to keep discipline and monitor possible changes in the system on an ongoing basis by persons supervising the supply chain. It is also necessary to know how the individual systems cooperate with each other, therefore the transparency of the system and continuous intensive training for employees are of crucial importance.

## **2 Analysis of how to Manage the Supply Chain**

In the surveyed company, logistic measures are used to assess the efficiency of the supply chain due to their reliability. However, in order to use the measures effectively, it is necessary to measure the current state of affairs before introducing improvement measures. Appropriately adjusted measures facilitate decision making and outline appropriate prioritization of tasks for the participant of the measured organisation [7]. A big advantage is the possibility of global application in international organisations, by making them easy to understand, as their systematic character is based on measurable results and numbers and not on general formulas. Key Performance Indicators (KPIs) are measures that assess and measure the extent to which objectives have been achieved. Through the use of KPI measures in an enterprise, we enable the achievement of the objectives of a given entity, without losing the sense of the strategy and mission of the organization [5]. As a result of the KPI analysis it is possible to identify problematic connections in the supply chain [1]. For the supply chain, the following KPIs are mainly distinguished, as presented in Table 1.

ERP systems, especially APS modules, can be adjusted to meet KPI targets. With the use of optimization tools, the APS system, using KPI guidelines, can plan production processes for specific resources, taking into account the limitations of individual supply chain actors.

**Table 1.** Selected KPIs to assess the supply chain, based on [12].

Category meter	Subcategories	Name meter / indicator
Expense	Expense total	Chain supply total expense
	Main processes	Cost of delivery, production, distribution, supply
	Ancillary processes	Information flow indicator, transport cost index. Material flow indicator, order cost indicator, innovative process indicator
	Outside costs	Outside environmental costs
Time	Lead time	Orders, handling processes, manipulation, manufacturing, production, delivery
	Time of reaction	Reactivity, readiness of delivery, speed of information flow
	Punctuality	Confidence of delivery
	Rhythmicity	Periodicity
	Reliability	Indicator of delays, downtime, average delay time
Quality	Customer satisfaction	Product availability, complaints, completeness of deliveries, openness of information, accuracy of communication
	Infrastructure	Level of computerization, technical infrastructure, efficiency environmental
	Processes	Processes of adding value, improving the implementation of processes, planning precision
Flexibility	Risk	Accuracy of forecasts, index of spare production capacity, risk of process performance, availability of information
	Service	Flexibility of supplies, availability of deliveries
	Specification market	Seasonality, nature of the product's properties

The surveyed company plans and manages the supply chain across Europe for the two categories defined for the organisation. These categories are:

- chewing gum and candies,
- cookies.

The supply chain for each category is managed separately, has separate reporting lines and is unique in terms of business strategy. By creating an integrated planning centre, IT systems are synchronized and uniform in terms of the company's logistics strategy. However, the planning centre does not make the most important decisions regarding the supply chain management strategy on its own. Separate positions and employees

within the organization are dedicated to building a vision of the supply chain for the entire organization and determining the direction to follow for the entire centre. Supply chain management is not located entirely in a single location, which does not facilitate supply chain management decisions.

Supply Chain Management includes processes related to demand, distribution, manufacturing, components, database and other tasks necessary to synchronize and integrate the supply chain. The weekly cycle starts with the daily development of distribution plans by the system, taking into account market and customer demand and planned procurement. Long-term demands and resource workloads are also automatically planned. The work of a Supply Chain Management Centre planner starts with checking unexecuted orders from the previous week and analysing changes in demand or distribution needs for products. Potential procurement risks are also checked on a daily basis to ensure that information is communicated as quickly as possible and that actions are coordinated to eliminate them. This is followed by adjustments to short-term production plans and the development of production plans for subcontractors. On the basis of the analysis of resource load, market needs and stock positions, medium term production is planned in order to create the best possible production plan appropriate and tailored to the customer's needs. Then the production plan is transferred to the factory and detailed scheduling of resources. On the basis of the schedule, a detailed, confirmed distribution plan for the products for the distribution centre is created.

While the production plan for the short and medium term is already completed, information is exchanged with the manufacturers in order to transfer the most important priorities for production. At the same time, at the end of the weekly cycle, the process of forecasting the demand for components and sharing the forecast with the deliveries takes place. In parallel, planners carry out work related to database management processes, meetings with supervisors and training courses. The weekly cycle ends with the release of the demand that is analysed and sent by the department to ERP and ASP systems, after which the cycle is repeated from the beginning. During the analysis of the supply chain, the following areas with potential for improvement were identified using the "5 whys" method:

- problems with component management: mainly due to an inappropriate database for component planning and a lack of adequate forecasting for key materials that were supplied by many suppliers,
- problems with the organisation of production: due to the lack of a system solution that would automatically create plans to synchronise production plans for similar product groups,
- management of market coverage: this was due to the lack of an understandable and easy-to-use tool presenting the current stockholding stocks for specific markets on a long-term and short-term basis and to inaccurate plans for the renewal and distribution of stocks in the markets.

### **3 Improvements in Supply Chain Management**

It took more than two years to implement these improvements, mainly in the areas of component and inventory management and production organisation.

#### **3.1 Improvements Related to Component Management**

Component management in the organization is divided between two positions. The first position is a central planner, whose tasks are more focused on the overall management of components and the creation of system possibilities of ordering components for the factory (e.g. the creation of purchase demand, on the basis of which contracts in the system are created, necessary to create orders to suppliers). The second position is the function of a factory planner, whose main task is to monitor daily material levels in the factory and to ensure that the components needed for production in a given location are available on time. If there are no components necessary to meet the production schedule, the central planner is the first point of contact for the planner at the factory. All material requirements result from the calculation of production plans through BOMs for component requirements in the SAP ECC system.

An analysis carried out at one of the factories showed that the main cause of material shortages are weaknesses in key activities, therefore an attempt was made to correct the processes and the following improvements were proposed:

- carrying out a comprehensive audit of the planning database for all active components in the system,
- the introduction of "best practices" for planners in the factory to increase the efficiency of their work,
- increasing integration with critical suppliers through weekly meetings to monitor potential supply risks from the supplier,
- agree on tariff quota levels for critical raw materials supplied from multiple sources.

#### **3.2 Improvements in the Organisation of Production**

The company's main focus was on the proper organisation of production, so the area was the most developed in terms of planning. However, due to the supply chain strategy, which was based on maximum responsiveness to customer orders, there was often a need to change the production plan in order to respond to consumer demand, which led to numerous unnecessary rearmaments in the factories. In order to reduce the changeover time in the factory, it was agreed that similar recipes of sweets should be produced as much as possible together, and the SAP APO system in which production is planned should offer these solutions automatically, reducing the number of necessary manual interventions in the system by the planner.

The principle was introduced that the chosen taste will be produced on a weekly basis, allowing for continuous production. Additionally, it was stated that rearmaments will be carried out after the end of the 120-hour production cycle, due to the lower need to involve human resources in the processes of line rearmaments.

### **3.3 Improvements in the Management of Stocks of Finished Products**

A central planner managed the selected product portfolio in many markets, i.e. if he produced an x-product in a specific factory, he was also responsible for the proper coverage of the product in all markets in Europe to which it was sent. Through the philosophy of measuring the complex customer level for a given market or product group within an organisation, there were inventory shortages for less important markets. Adequate risk and inventory management for finished products had to be developed. The tools developed meet the following business needs:

- automatically shows current and planned inventories (for each of the existing products in each market) for a 52-week horizon, adding up the demand for several distribution centres due to the possibility of balancing inventories and orders in a given country,
- the database source can be refreshed on a daily basis and uses only SAP systems,
- collects information on short-term stocks on a daily basis and on a three-week horizon,
- displays the information in a clear, comprehensible and easily transferable way in further communication in the supply chain,
- groups products in order to facilitate portfolio management and prioritise products in order to prioritise the elimination of procurement risks.

The scale of demand coverage has been set as follows: the current minimum number of days of stock coverage is set separately for each product and market:

- over 120 days: to be corrected for exceeding the deadline for the ability to sell a full value product to customers,
- 119-60 days: to be corrected if there are no special business restrictions due to the fact that half of the time limit for selling a full value product to customers is exceeded,
- from 59 to 15 days: acceptable, but with higher numbers of corrective actions,
- from 14 days to 9 days: alarming, necessary correction of supply plans,
- from 8 days to 0 days: for an absolute check, an immediate change of supply plans is needed.

In order to identify supply risks more quickly, a tab identifying all risks has been introduced and the information will be transmitted by the central planner to the generating unit for setting priorities for stock renewals.

## **4 Selected KPIs**

In order to confirm the effectiveness of the implemented improvements, several KPIs were analysed, and the scope of the analysis was broad enough to confirm the lack of randomness of results. Particular attention was paid to:

- level of customer service, where:

$$POK = \frac{D_o}{Z_o} \cdot 100\% \quad (1)$$

(*POK* - level of customer service [%], *D<sub>o</sub>* - number of product packages delivered [packages], *Z<sub>o</sub>* - number of product packages ordered [packages]),

- the share of undelivered product packages due to the purchasing department, where:

$$POKN = \frac{Z_{nz}}{D_o} \cdot 100\% \quad (2)$$

(*POKN* - level of customer service for undelivered packages [%], *Z<sub>nz</sub>* - number of undelivered product packages due to a supply error [packages]),

- conformity of production with the schedule, where:

$$Z_zH = \frac{|L_z - L_w|}{L_z} \cdot 100\% \quad (3)$$

(*Z<sub>z</sub>N* - compliance of production execution with the schedule [%], *L<sub>w</sub>* - quantity of produced product [kg], *L<sub>z</sub>* - quantity of planned product [kg]),

- a stock recovery cycle for finished products in the supply chain, where:

$$COZ = P_1 > P_2 \quad (4)$$

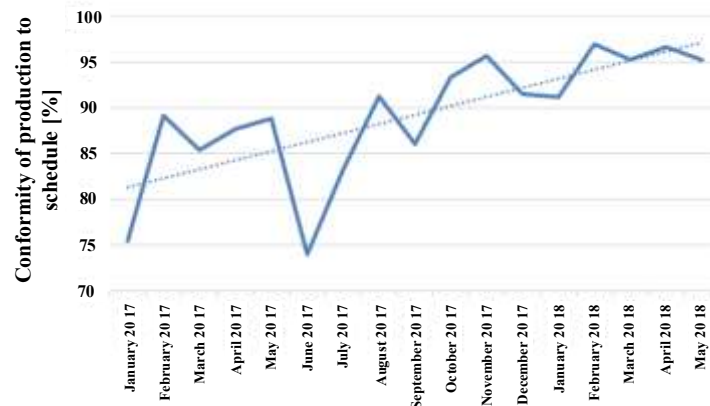
(*COZ* - stock recovery cycle for finished products [days], *P<sub>1</sub>* - previous production of the same product at the factory [days], *P<sub>2</sub>* - subsequent production of the same product at the factory [days]),

- the time of stockpile for finished products (the time during which the stock of finished products would run out without renewal of stocks for the selected product), where:

$$CZA = \frac{Z_d}{P_p} \quad (5)$$

(*CZA* - stock time for finished products [days], *Z<sub>d</sub>* - stock available for the product [kg], *P<sub>p</sub>* - expected demand for the product [kg/days]).

Detailed figures adopted by the above-mentioned indicators and the levels of their development in recent years are a secret of the surveyed company and cannot be presented. However, it can be generally stated that all key indicators confirmed the legitimacy of the introduced improvements in the logistics chain. However, the greatest impact of the implemented improvements was observed in the compliance of the production with the schedule, as shown in Figure 3.



**Fig. 3.** Evolution of the index of conformity of production execution with the schedule.

The trend line shows a steady increase in the level of this indicator, but in June 2017 we can see the local minimum of the indicator, caused by an unforeseen seasonal surge in demand, caused by the beginning of the hot summer.

## Conclusions and Summary

The implementation of improvements in supply chain management in an integrated planning centre is a multi-stage and long-term task. This article focuses on presenting the idea of building a modern supply chain and the concept of logistics integrating the flow of product and information. Efforts were also made to clarify concepts such as logistics strategy or planning in supply chain management in the broad sense of the term. It also describes the phases of supply chain integration and the strategy of effective customer service in buyer-oriented supply chain modelling. Attention is paid to the role of modern IT systems in planning and management of the organization, as well as their types, structure and areas of operation and functionality in the company. The function and role of the most important from the point of view of flexible supply chain management and IT systems of KPIs in the company are described. The presented example of FMCG supply chain improvement should be treated as a case study for further research and development works.

## References

1. Grzybowska, K.: Reconfiguration to Renovation in a Sustainable Supply Chain. In: Intelligent Systems in Production Engineering and Maintenance - ISPEM 2018, pp. 761-770. Springer, Wroclaw (2019).
2. Grzybowska, K., Hoffa-Dąbrowska, P.: Durability of Supply Chains as Non-renewable Systems. In: Burduk, A., Mazurkiewicz, D. (eds.) Intelligent Systems in Production Engineering and Maintenance – ISPEM 2017, pp. 227-237. Springer, Wroclaw (2018).



3. Harrison, A., Van Hoek, R. I.: Logistics management and strategy: competing through the supply chain. 3rd edn. Prentice Hall Financial Times, Harlow, England (2008).
4. Jacobs, F. R., Berry, W. L., Whybark, D. C., Vollmann, T. E.: Manufacturing planning and control for supply chain management. APICS/CPIM Certification Edition. McGraw-Hill, New York (2011).
5. Jasiulewicz-Kaczmarek, M., Bartkowiak, T.: Improving the performance of a filling line based on simulation. In: IOP Conference Series: Materials Science and Engineering, vol. 145(4), pp. 042024. ModTech 2016, Romania (2016). 10.1088/1757-899X/145/4/042024.
6. Kowalska, A.: Innovation of the Economies of European Union Countries in 2009-2016. In: Proceedings of the 30th International Business Information Management Association Conference (IBIMA), pp. 3514–3523. Madrid, IBIMA (2017).
7. Kowalski, A., Królikowski, S., Szafer, P.: Methods and techniques for evaluating the productivity of production processes in the automotive industry. In: IOP Conference Series: Materials Science and Engineering, vol. 400, pp. 062017. ModTech 2018, Romania (2018). 10.1088/1757-899X/400/6/062017
8. Mell, P., Grance, T.: The NIST Definition of Cloud Computing. National Institute of Standards and Technology, 53(6):50, Gaithersburg (2009).
9. Slack, N., Brandon-Jones, A., Johnston, R.: Operations Management. 7th edn. Pearson Education, Harlow, England (2013).
10. Sobaszek, Ł., Gola, A., Świć, A.: Predictive Scheduling as a Part of Intelligent Job Scheduling System. In: Intelligent Systems in Production Engineering and Maintenance – ISPEM 2017, pp. 358-367. Springer, Wrocław (2018).
11. Trkman, P., Budler, M., Groznik, A.: A business model approach to supply chain management. Supply Chain Management: An International Journal 20(6), 587–602 (2015). 10.1108/SCM-06-2015-0219.
12. Tundys, B., Rzeczycki, A., Ziolo, M., Jankowski, J.: Models of an Integrated Performance Measurement System of Intelligent and Sustainable Supply Chains. In: Nguyen, N. T., Attachoo, B., Trawiński, B., Somboonviwat, K. (eds.) Intelligent Information and Database Systems - 6th Asian Conference, ACIIDS 2014, pp. 504-514. ACIIDS 2014, Thailand (2014).
13. Whittington, R.: What is Strategy - and Does it Matter? 2nd edn. Cengage Learning EMEA, London (2001).

## Is Internet Voting a Way how to Improve Cost-efficiency of the Czech Electoral System?

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**Abstract.** Modern society in developed countries is increasingly using information and communication technologies (ICT). In many areas, people cannot imagine life without ICT because they make it easier and faster to decide, manage or evaluate projects and activities, but they have not yet fully succeeded in some areas. One of these forgotten areas is the election and introduction of an electronic way of voting. Politicians debate whether an internet or correspondent form of voting could increase the voter turnout, and at the same time reduce the cost of holding elections. The paper analyzes the use of internet voting in Estonia, which this method of voting allows. Furthermore, the paper analyzes the data on access of Czech households to the Internet and also the share of households using the internet for financial transactions that are comparable in terms of sensitivity of electoral data. Based on this analysis, it was found that internet voting method which uses the Internet cannot completely replace the traditional method of voting. In the case of the Czech Republic, there would probably be no increase in voter turnout or reduction of election costs.

**Keywords:** Internet, Internet Banking, e-Voting, Internet Voting, Election.

### 1 Introduction

Before 1989, the elections were used as a confirmation of power by the ruling Communist Party, and the free competition of other political parties virtually did not exist. The breakthrough came after this year. Then, the voters could freely decide which political party (on the basis of the electoral program and the vision of the future direction of the country) would support the election. [6]

However, the initial enthusiasm for free elections soon ceased. While the turnout in 1990 was 97%, electoral participation declined over the next few years, regardless of the type of election. At present, only 65% of the votes in the Chamber of Deputies of the Parliament of the Czech Republic, which is generally considered the most important, are elected.

The electoral system of the Czech Republic, from the point of view of citizens, consists in coming to the polling station and giving a paper vote to the ballot box. In the Czech Republic unlike most European Union countries there is no alternative form of voting (e.g. correspondence or electronic) allowed. [11]

In addition, holding an election is relatively expensive, every election costs the state treasury of approximately CZK 500 million, which represents almost CZK 40 per eligible voter [7] and the election costs in the coming years may be expected to rise. Professionals and politicians are therefore again starting to discuss how the way in which voting could be adjusted to increase voter turnout and, at the same time, that any adjustment to the voting method would not cause an extreme increase in the cost of the election. Besides the requirements for the possibility of correspondence voting, the supporters of the Internet voting method are also invited. [1, 10]

It is very difficult to determine the influence of the turnout on voting. It is not possible to obtain any empirical data, all the presented data come from surveys and their relevance can be very controversial. One way to identify potential impacts on voter turnout or election costs is to use data from abroad, for example, Estonia, which allows electronic voting on the Internet. Even though the data on participation and costs from another state cannot be fully taken into account as different countries differ from each other, basic analysis of Internet usage and Internet voting can contribute to the basic idea of the impact of Internet voting in the Czech Republic.

## **2 Literature Review and Methodology**

Article 18 of Act No. 1/1993 Coll., The Constitution of the Czech Republic, provides that every citizen who has reached the age of at least 18 years has the right to vote. Decision-making of citizens - eligible voters whether or not to participate in the election depends, in addition, to political conviction or awareness on the importance of the election process also on the circumstances related to their personal life.

The goal of the government is to provide public goods and services for citizens (including preparation and holding of elections) in the most efficient way [2] and there are many articles about analyses and possibilities how to improve it. [3] The efficiency of provided public goods can be understood as providing the greatest possible comfort for citizens with a minimum amount or quantity of waste, expense or unnecessary effort. By analogy, in the case of the electoral system, the government should hold elections as a public service in such a way that citizens are actively involved in voting (vote) as cheaply as possible but as efficiently as possible.

However, the electoral system of the Czech Republic cannot be considered as cost-efficient. [9] In order to save money, there is, therefore, a growing debate about the introduction of electronic voting methods and different political parties, and experts suggest that some changes be made in the current electoral system, the most common of which is the introduction of a voting option using the Internet or at least a correspondent vote. [1, 10]

Correspondent voting would not, however, be allowed by everyone as an internet vote, according to current proposals. Therefore, it can be assumed that the introduction of a corresponding form of voting would not reduce the cost of holding elections. In the case of voting using the Internet, such a conclusion cannot be made without further examination. It is necessary to take into account how many citizens have an internet connection and actively uses this connection. Based on this analysis and other

similarities, it is then possible to estimate what impact the voting on the Internet could have.

The aim of this paper is to analyze the situation of households in the Czech Republic in connection with the internet connection and Internet use and to assess the potential impact of introducing the possibility of the electronic voting method using the Internet. Because of the sensitivity of data input and security, the Internet voting is similar to Internet banking (authorization, authentication, management of personal or sensitive data, etc.), the analysis focuses on using the Internet for the purpose of financial transactions (Internet banking). It is first established how large the population has Internet connections and then how much of this Internet connection population is using for Internet banking. These data are, in the last step, compared to similar data from Estonia, which allows citizens to vote on the Internet.

The paper uses freely accessible data published by official state institutions - statistical offices or directly government institutions.

### 3 Results

Internet access in Europe is quite common and the Czech Republic is not an exception. While in 2010 access to the internet or the Internet was used by almost 70% of the European Union (EU) citizens, it was more than 80% in 2017. Most citizens with access to the Internet live in Luxembourg, Denmark, and Sweden for over a year (over 96%). Estonia and the Czech Republic are lagging behind only a few percents, both countries being rated above the EU average in terms of Internet access. [4]

However, the above statistics also include citizens who have access to the Internet at work, but not in their own household. The total number of households with Internet access is, therefore, several percentage points lower, but it does not differ significantly. In the Czech Republic, 80.475% of citizens have access to the Internet from home, i.e. only 4% less than the Internet usage statistics.

In terms of household income, there are significant differences in the Czech Republic. While almost all citizens with the highest income (Q4) have access to the Internet in their home, more than half of the least income (Q1) citizens do not have Internet access:

**Table 1.** Internet in households 2013 – 2018 (%) [4].

Income group	2013	2014	2015	2016	2017	2018
Q1	29.0	32.4	33.8	38.6	42.6	47.1
Q2	50.5	56.5	57.2	59.4	70.7	78.8
Q3	86.4	87.0	85.8	88.1	93.9	96.5
Q4	94.9	97.4	96.8	98.0	99.3	99.5

A positive correlation can be found between the household income group, age, economic activity, and education. In general, Internet access is more likely to be young people or middle-aged, university-educated people or women on parental leave. On the other hand, elderly people, with lower education, do not usually have access to the Internet:

**Table 2.** Internet in households 2013 – 2018 (%) [4].

Economic activity (16+)	2013	2014	2015	2016	2017	2018
Employed	88.7	90.7	92.0	92.6	95.1	95.4
Unemployed	66.3	75.7	73.7	68.7	72.3	80.2
Women on parental leave	89.4	94.6	93.9	94.1	94.7	97.9
Students	98.9	99.7	99.0	98.6	99.7	99.8
Old retirees	24.2	31.1	33.1	35.0	37.0	40.8
Disabled retirees	43.8	55.7	50.4	56.9	62.8	66.9

It is interesting to see what services these people use. Most (especially young people) use the Internet to communicate on social networks and to search for the necessary information. About the knowledge, a smaller proportion of people used the internet to order some goods: About 80% of people connected to the Internet used the Internet to buy goods in 2017, but only 65.3% of all Czech citizens. Even though this figure may appear to be high at first glance, it is relatively low in terms of the usability of the Internet for voting purposes in the elections. In the case of Internet banking, this percentage is much lower:

**Table 3.** Internet banking usage in households 2013 – 2018 (%) [4]

Economic activity (16+)	2013	2014	2015	2016	2017	2018
Employed	55.5	59.7	63.1	65.9	71.8	76.5
Unemployed	30.0	28.9	32.2	29.9	37.5	43.2
Women on parental leave	57.9	69.0	61.8	68.5	73.4	85.9
Students	24.9	34.0	31.6	33.6	37.4	47.0
Old retirees	7.7	10.7	11.9	12.9	14.5	17.4
Disabled retirees	16.0	19.1	18.5	18.2	24.9	30.8

While Internet access in the Czech Republic accounts for more than 95% of employed people, internet banking uses only 76.5%. Given that banks are no longer charging for Internet banking, this low share of Internet banking cannot be influenced by monetary factors. The explanation must, therefore, be rather non-financial, for the most part, probably in confidence in this service. The most significant difference is in the use of the Internet and the use of internet banking in the elderly where Internet banking is not

used by half of those seniors who have access to the Internet. Therefore, it is not easy to assume that in the case of the introduction of electronic elections (Internet voting), those people who have been distrustful in online banking over the Internet would vote. On the contrary, the proportion of citizens who would use the option to vote over the Internet would probably be even lower.

For comparison, a comparison can be made with Estonia already mentioned:

**Table 4.** Internet banking and I-voting usage in 2012 – 2017 comparison [4, 12].

	2012	2013	2014	2015	2016	2017
<b>Estonia</b>						
Internet connection (%)	78.4	80.0	84.2	88.4	87.2	88.1
i-Banking (%)	68.1	72.2	76.6	80.7	78.6	79.2
i-Voting / el. voters (%)	-	12.3	11.4	19.6	-	16.9
i-voting (%)	-	17.0	14.9	24.3	-	21.3
<b>The Czech Republic</b>						
Internet connection (%)	73.4	74.1	79.7	81.3	82.2	84.6
i-Banking (%)	34.2	41.5	46.0	48.4	51.4	56.6
i-Voting / el. voters (%)	-	-	-	-	-	-
i-voting (%)	-	-	-	-	-	-

In Estonia, internet access in 2017 had a total of 88.1% of citizens, of which 80% of citizens (i.e. 90% of citizens with access to the internet) used internet banking. Internet voting in municipal councils, which took place in Estonia in 2017, was used by only 17% of the eligible voters. This is only 21% of citizens who used Internet banking this year and who can, therefore, assume elementary confidence in ICT and their security. The share of citizens who actively participated in the poll and voted through the Internet was approximately 21%. The proportion of citizens who have Internet access who use internet banking and who vote in the elections over the Internet is roughly the same over the last five years, so we cannot say that more caution and return to the traditional way of voting have taken place in recent years. On the basis of these data, it can be stated that the Estonian Internet voting method did not convince even 10 years after their release.

In the Czech Republic, 84.6% of citizens had an internet connection in 2017, Internet banking was used by just under 57% of citizens. Based on this data, when internet banking is used by only 67% of citizens who have access to the internet, it can be said that Czechs are not much more trustworthy to use the internet for private and sensitive activities with more cautious and modern technologies. If the proportion of citizens who would have voted in the Czech Republic using the Internet were the same or similar as in Estonia, about 12% of the eligible voters would vote in the Czech Republic over the internet. As the vote in the Czech Republic is the highest, as a rule, in elections to the Chamber of Deputies of the Parliament of the Czech Republic (about 65%) [7], it would mean that about 80% of eligible voters would vote in the traditional way. In

addition to the state investment in the information system that would allow Internet voting and the cost of running it, it would have to be the money spent on holding the elections in the traditional way.

Even though the findings of observing the behavior of citizens in one country and transferring it to the conditions of another country cannot be used, based on the above findings it can be assumed that the implementation of the possibility of internet voting in the Czech Republic would not bring benefits in the form of cost reductions and cost-efficiency improvements.

#### **4 Discussion and Conclusion**

At present, more and more researches are focusing on measuring and enhancing efficiency in both private and public administration. [8] However, public goods and services provided to their citizens are not always provided efficiently, economically and effectively, even in the case of elections and the electoral system. [7, 9]. One of the options that politicians in the Czech Republic are currently discussing is the introduction of an alternative way of voting - a corresponding vote or Internet voting. [1, 10]

However, Internet voting is available in several European countries only, of which Estonia or Switzerland is the best known. After the introduction of this voting option, scientists have begun to conduct research to determine whether this alternative method of voting has increased voter turnout. It was not in the case in Estonia or Switzerland. [5, 13]. In Estonia, after almost 10 years of Internet voting, over 25% of the eligible voters vote on the internet. In particular, they are middle-aged voters, young people and retirees are either not elected or elected in the traditional way. [13]

The arguments of Czech politicians that alternative voting methods would increase voter turnout are therefore unrelated to foreign examples. It is not only that election participation is not likely to increase, but also increase the cost of holding elections. Since elections have to be held for all citizens (no one has to be excluded from the use of this public service), besides the costs of the electoral information system, the government would still have to hold everything connected with the traditional way of voting. In that case, the cost of holding elections will surely increase. The cost-efficiency of the Czech electoral system would have declined in this case. When introducing modern technologies, it is therefore first necessary to convince citizens that these technologies are safe, technology that citizens can trust. This is the only way the company will accept the change of the electoral system and the introduction of a new method of voting that will use modern information technologies and the possibilities available in the 21st century.

## References

1. Aktualne.cz: Návrh volit ze zahraničí i korespondenčně vláda nezavrhla. Problémy jsou s termíny i druhými koly, <https://zpravy.aktualne.cz/domaci/navrh-volit-ze-zahranici-i-korespondencne-vlada-nezavrhla-pr/r~4c585ee48f2b11e88202ac1f6b220ee8/?redirected=1544895129>, last accessed 2018/12/15.
2. Asatryan, Z., De Witte, K.: Direct democracy and local government efficiency. *European Journal of Political Economy*, 39, 58–66 (2015).
3. Bergman, M.U., Hutchison, M.M., Jensen, S.E.H.: Promoting sustainable public finances in the European Union: The role of fiscal rules and government efficiency. *European Journal of Political Economy*, 44, 1–19 (2016).
4. Czech Statistical Office: Use of Information and Communication Technologies in households and among individuals, <https://www.czso.cz/csu/czso/vyuzivani-informacnich-a-komunikacnich-technologii-v-domacnostech-a-mezi-jednotlivci>, last accessed 2018/12/15.
5. Germann, M., Serdült, U.: Internet voting and turnout: Evidence from Switzerland. *Electoral Studies*, 47(June 2017), 1–12 (2017).
6. Kostecký, T. et al.: Geografie výsledků parlamentních voleb: vzorce volebního chování v Česku 1992–2013, 1st edn. Sociologický ústav AV ČR, v.v.i., Prague (2015).
7. Král, M., Hájek, L.: Analysis of Parliamentary Elections Costs in the Czech Republic. In: Jedlička, P., Soukal, I., Marešová, P. (eds.) Double-blind peer-reviewed proceedings part I. of the International Scientific Conference Hradec Economic Days 2018, pp. 472–481, University of Hradec Králové, Hradec Králové (2018).
8. Král, M., Hájek, L.: Modeling and optimization of cash processing costs in the Czech Republic. In: Novák, P. et al. (eds.), Proceedings of the 8th International Scientific Conference Finance and Performance of Firms in Science, Education and Practice, pp. 420–433. Tomas Bata University in Zlín, Zlín (2017).
9. Král, M., Olszańska, A.M.: Electoral System Cost-Efficiency in the Czech Republic. In: Dvořáková, P., Baisa, B. (eds.) Proceedings of the 22nd International Conference Current Trends in Public Sector Research, pp. 66–73, Masaryk University, Brno (2018)
10. Parlamentnilisty.cz: TOP 09 volá pro korespondenčním hlasování. Prý pro statisíce Čechů v zahraničí. A ozvaly se podezřívavé reakce veřejnosti, <https://www.parlamentnilisty.cz/arena/monitor/TOP-09-vola-pro-korespondencnim-hlasovani-Pry-pro-statisice-Cechu-v-zahranici-A-ozvaly-se-podezrivave-reakce-verejnosti-545719>, last accessed 2018/12/18.
11. Reterová, S.: Alternativní způsoby hlasování. Od tradičních metod k on-line volbám. 1st edn. Periplum, Prague (2008).
12. Valimised: Statistics about Internet Voting in Estonia, <https://www.valimised.ee/en/archive/statistics-about-internet-voting-estonia>, last accessed 2018/12/15.
13. Vassil, K. et al.: The diffusion of internet voting. Usage patterns of internet voting in Estonia between 2005 and 2015. *Government Information Quarterly*, 33(3), 453–459 (2016).



## Innovation and Socio-economic Development of Smart Furnitures by Patent Applications Analysis

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**Abstract:** Smart Home and Smart City are nowadays frequently used terms which most of the smartphone users and modern urban residents are familiar with. Both these terms cover many of other subterms like Smart Energy, Smart Street, Smart Economy, etc., where one of the most closer for people is furnitures – in a digital world in the form of Smart Furnitures. The goal of this paper is to provide an analysis of innovation and socio-economic development in the area of these Smart Furnitures by the use of patent application analysis and an economic evaluation based on the valuable research in the field. We analyzed 100 patents from Espacenet database, showed the trend in the field including most valuable companies in the area and also the value of patents confirming the investment potential of the field.

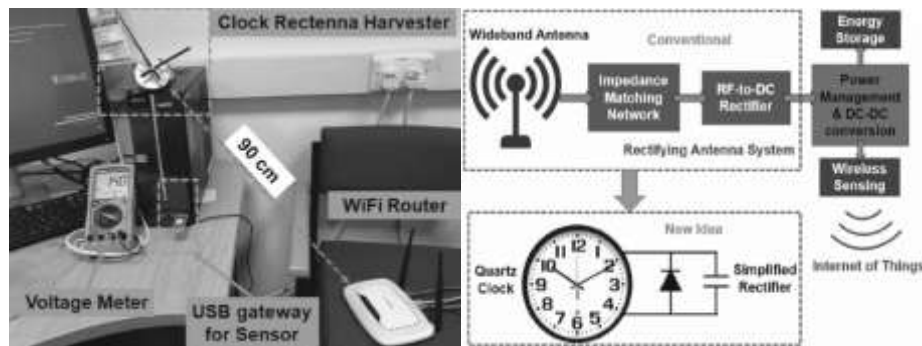
**Keywords:** Smart Furniture, Value, Market, Analysis, Patent Application, Intellectual Property, Innovation, Espacenet.

### 1 Introduction

Smart Devices and Smart Furniture as a component of Smart Home for home applications have attracted significant interests in the past decades. As a typical example, we can name the most actual research for clocks with integrated wireless energy harvesting and sensing functions (Fig. 1) [10] and example of Google Home smart speaker.

Smart Furniture phrase is unfortunately used in various terms, connections and meanings from the design of furniture to be smart, to wall mounted electric socket with an internet connection. Here are some examples of existing definitions:

- Ito, Iwaya, et al. in 2003 [11] defined: „Smart Furniture is a platform for systems to realize Smart Hot-spot. By simply placing the Smart Furniture, we can turn legacy spaces into Smart Hot-spots. Smart Furniture is needed to be equipped with a networked computer, I/O devices, and sensors. Coordination with existing network infrastructure or user's devices is also required.
- Vaida, Gherman, et al. in 2014 [13] provide a definition: "Smart Furniture is the furniture which brings added value, functionality, comfort, and elegance to fit every personalized requirement issued by the user."
- Braun, Majewski et al. in 2016 [2] defined: „Smart Furniture is able to detect the presence, posture or even physiological parameters of its occupants" (Fig. 2).
- According to Technavio's smart furniture market research report [3] “Smart furniture is powered by technological advances such as network connectivity via Bluetooth or Wi-Fi and others, which helps users enhance their furniture beyond its basic analog functions. Smart furniture helps consumers in browsing the Internet for news feeds, weather forecast updates, listen to music. It also offers wireless charging slots for smartphones and has features like distance operation and others”.



**Fig. 1.** Left: The real application example of using Smart Furniture - clock antenna to harvest energy from a typical WiFi router at a distance of 0.9 m [10]. Right: The block diagram for energy harvesting quartz clock and their applications in energy storage and wireless sensing [10].



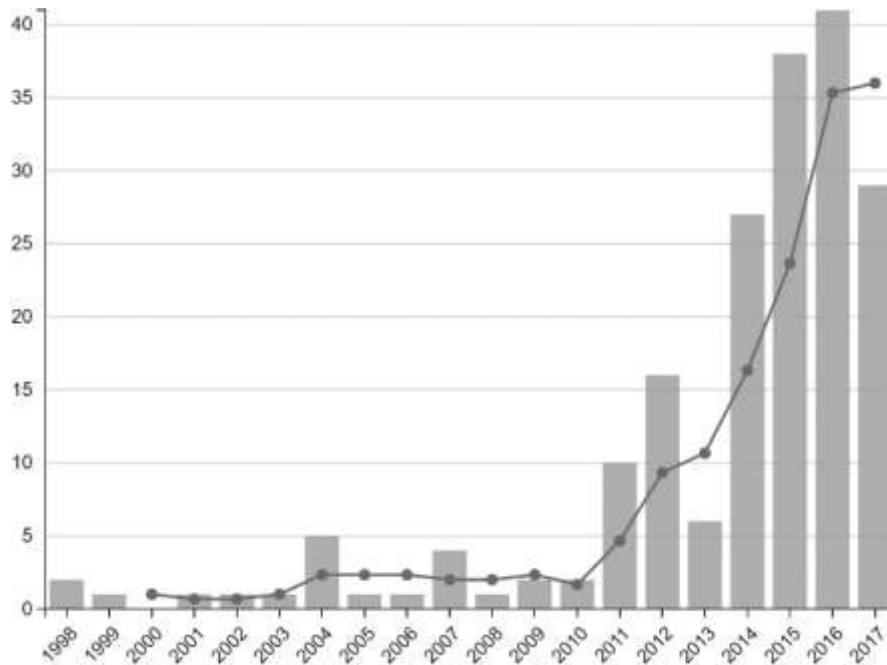
**Fig. 2.** Potential scenarios for wireless occupancy systems. Bed on the top left, office chair on the top right, wheelchair on the bottom left, and couch on the bottom right [2].

Due to the overlap between industry, technology and people society resulting in the research in basic and also applied research a need to cover a survey of available intellectual property (patents) is needed. To find results close enough to Smart Furniture, this phrase will need to be searched as it is in:

- Topic search (title, abstract and keywords if available) or
- Full-text search (including Claims and Description).

## 2 Patent Database Analysis - ESPACENET

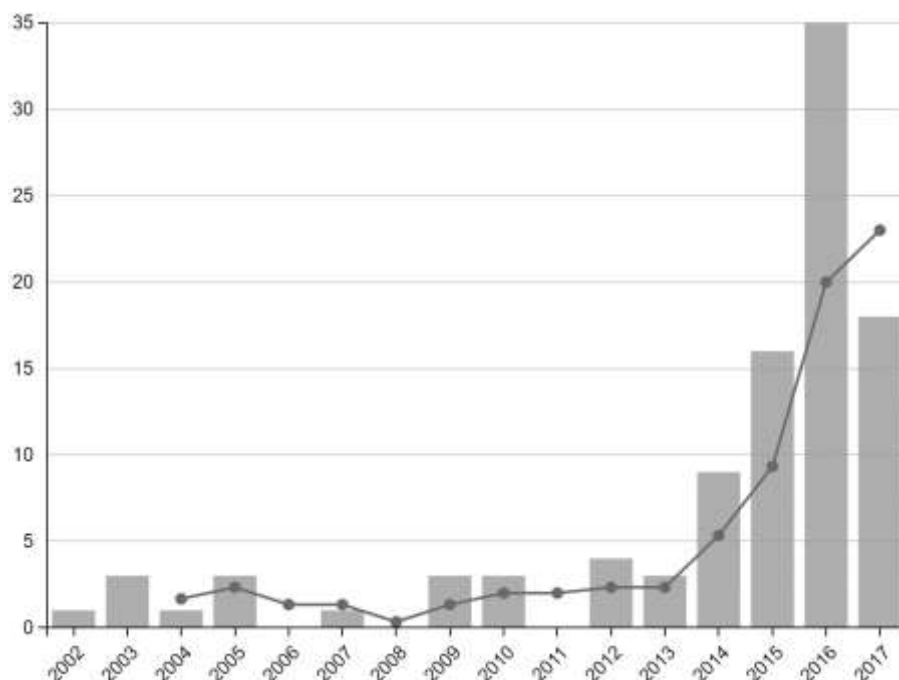
Patent database ESPACENET provide 189 results based on search phrase Smart Furniture (as topic search) for the last 20 years between years 1998 up to 2017 (based on application date) as there are only 3 records for 2018 yet and older patents are not relevant for our criteria (Fig. 3).



**Fig. 3.** Distribution of patents in years for Smart Furniture *topic* at ESPACENET database by application date (total of 189).

As there is a possibility to search also a description of patent applications, it is appropriate to cover even this option while searching for results. For the same time frame of 20 years, search result provides an output of 13109 records which is a high number. From these records, 4734 patents were granted.

Unfortunately, these patent applications for given specific search phrase Smart Furniture also cover many records which are not in the connection of Smart Furniture, but in other meaning. For example patent Trust-based resource sharing method and system [15] contain the following sentence in abstract "The present invention is a trust-based resource sharing method and system for managing resources such as accommodations, automobiles, bicycles, equipment, instruments, tools, furniture, and the like during the lease period, using the Internet and smart home technology.". It is possible to limit a search by specific CPS code, or by research area, unfortunately for given phrase smart Furniture it not result to the requested output. Thus we change search phrase from Smart Furniture to exact "Smart Furniture" which provide more precise results. After applying the full-text search, we got 100 results (Fig. 4).



**Fig. 4.** Distribution of patents in years for “Smart Furniture” phrase anywhere in the application text (full-text search) at ESPACENET database by application date in last 20 years (total of 100).

ESPACENET database provides several searching possibilities. Main is the topic search as it was used already, but instead of primary literature databases (ISI WOK, SCOPUS, etc.) it also offers other searching options which can provide additional results (Claims and Description). These results are summarized with the same searching conditions (years 1998-2017 and application date) and exact phrase “Smart Furniture”:

- Topic (title, abstract): 33 patents,
- Claims: 11 patents,
- Description: 72 patents,
- Full text: 100 patents,
- Applicants (name of company): 22 patents,
- All: 122.

Previous summarization cover also records for the case when “Smart Furniture” is used as the name of the company. Unfortunately, these records need to be excluded from searching as in this case the patents from these companies have no relation with smart furniture in fact, as they not contain searched exact phrase. Thus the following analysis will be provided for results (100 records) from searching by full text (not including the name of applicants – companies).

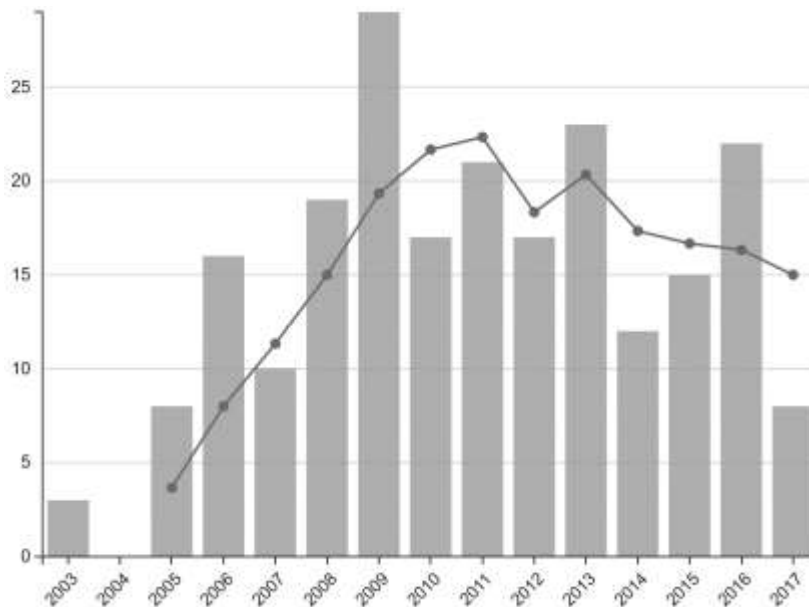
Applicant companies cover Amazon Tech Inc. (17), Qualcomm Inc. (9), Samsung electronics co ltd. (3), A9 com Inc. (2), Huawei device co ltd (2), IBM (2), Intel Corp. (2), Nokia Corp. (2), Tata Consultancy services ltd. (2), etc. As the full-text search results for the exact phrase "Smart Furniture" are more precise instead of only Smart Furniture in topics, the trend is, even more, increasing in last three years (2015-2017) what confirming the importance of the area for companies (Fig. 4).

Countries from where applicants are from containing mainly USA, China, Canada, Korea and others (Table 1).

**Table 1.** Applicant countries at ESPACENET database.

Country (Applicant)	Patents containing "Smart Furniture"	Patents citing "Smart Furniture" patents
United States	38	192
China	18	
World	4	9
EU		7
Canada	6	
Germany		6
Korea, Republic of	4	1
France	2	1
Australia	2	
Great Britain		2
Finland	2	
India	2	
Netherlands	2	
Japan		1
Mexico	1	
Taiwan	1	
Total	100	220

From the all 100 submitted patent applications only 37 is granted, while 63 is not granted yet. Another critical evaluation can be based on citation count for every patent application. These can provide a trend and also investors and companies interest in a given area of research/invent (Fig. 5).



**Fig. 5.** Distribution of citing patents in years for “Smart Furniture” patent applications searched by full text (100) at ESPACENET database (total of 220).

### 3 Patents Value Analysis

The patent application represents in most of the cases a result of some invention based on knowledge, research, project, etc. Not every patent application reach the level of granted application as well as not every patent application return the amount of financial investment to applicant/inventor. There are some basic patent application evaluation criteria which can help to recognize the value of the patent. One of the most valuable and easy to recognize is the number of patent citation for a given analyzed application [9,14, 16]. As the researcher use article citation count as a standard article quality evaluation, it can be easily stated that article from Hall, Jaffe, and Trajtenberg from 2005 [5] is the absolute base for prediction of market value based on patent citation analysis because of 1144 citations at SCOPUS database and 1011 citations at ISI WOK. These authors from University of California Berkeley, USA (Hall); Brandeis University, USA (Jaffe); and Tel Aviv University, Israel (Trajtenberg) provide phenomenal results based on research of patents and citations for 1963-1995. They estimated Tobin's q equations on the ratios of R&D to assets stocks, patents to R&D, and citations to patents.

They stated the median value of citations from future patents to 6.33 (based on years 1979-1988) while mean value is 7.95. To understand the context of citation data they put an example of the most highly cited patent since 1976 is patent #4,440,871, assigned to Union Carbide Corporation in 1984. This patent received 349 up to July 2003. This

patent expired on 26th July 2002 while it received a total number of 817 citations up to now (November 2018).

Straightforwardly, they stated, that:

- an increase of one percentage point in the R&D intensity of a firm (i.e., in the ratio R&D/Assets) leads to a similar increase in market value, (i.e., about .8%);
- one additional patent per million dollars investment of R&D boosts the market value of the company by about 2%,
- and an additional citation per patent increase value by over 3%.

The impact of citations per patent is also confirmed by Harhoff et al. from University of Munich and Harvard (1999) (564 citations in SCOPUS) which reported, that a value of the patent is consistent with the "million dollars" worth of a citation [6].

To cover an extensive distribution of citations per patent they break the citation counts to several categories (Table 2).

**Table 2.** Evaluation of patent value based on citation count separated by the median value of citation (6.33) [5].

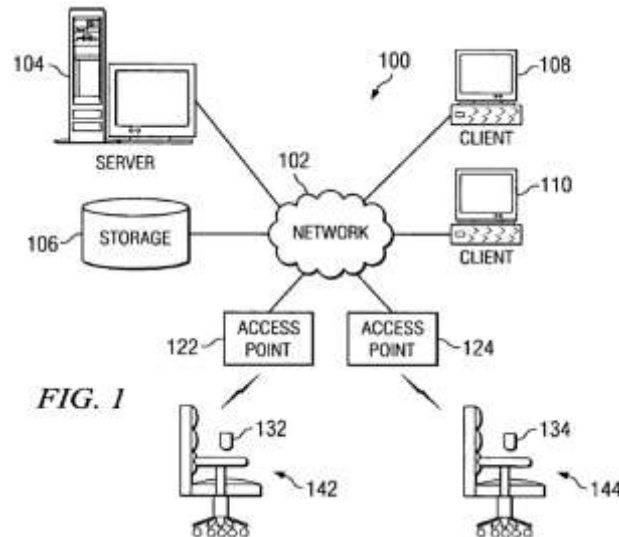
Citations/Patent	Value of company	Value of patent/citation [mil. USD]
0-4	Same	1.0
5-6	Same	1.0
7-10	10% more	1.1
11-20	35% more	1.35
>20	54% more	1.54

Hall et al. [5] also confirmed this values on the example of 143 most innovative companies in the market with a median value of more than 20 citations per patent (for the whole patent portfolio of a company). These companies cover names as Intel, Compaq, etc.

For the given example of "Smart Furniture" phrase "RFID smart office chair" patent by Hagale et al. [4] (Fig. 6) is the most cited patent (84 times cited by other patents) from all patents covered by a search in the ESPACENET database (Table 1) where total citations number is 220. Also, this patent falls into the most innovative companies as the inventor is IBM company.

Based on values in the table (Table 2) the price of this patent can be worth of 130 mils. USD (84 x 1.54 mil USD). This patent (by Hagale et al. [4]) was also the first relevant patent in the history containing the phrase "Smart Furniture". Moreover, it contains "Smart Furniture" phrase 4x in Abstract, 40x in Claims and 27x in Description.





**Fig. 6.** Schema of Smart Furniture by Hagale et al. from IBM company in August 2004 [4].

Other patents from topic search of “Smart Furniture” unfortunately not have any citation related to “Smart Furniture” in title or abstract excluding only one other “Novel dining table capable of achieving combined and separate use of mahjong machine and dining table” from Chen Jinchen – China (CN203914053 (U), 2014) with one cited patent [7].

For the full-text search of "Smart Furniture", there are several highly cited patents (Irobot corp. (113 citations) [8], IBM (22 citations) [1]) from most innovative companies which confirmed evaluation done by Hall et al. [5].

One of the most current patent application from China with world coverage from the 2018 year[12] deals with a personalized Smart Furniture which can be controlled by a plurality of options based on the information determined by gesture recognition and emotion recognition results. They declared three types of inputs as electrical, audio and video signal which need to be analyzed [15].

## 4 Conclusions

The goal of this article was to analyze the current state of the art in smart furniture area by a patent database and show possibilities for patent evaluation including economic parameters. Our analysis covered 100 patent applications from Espacenet database as well as 220 citing patents. Using several options for analysis we showed step by step value of selected "Smart Furniture" area, as well as economic potential with determination of value per patent based on citation count, which was based on the most cited literature in the field by Halle et al. [5] containing 1011 citation from ISI WOK database up to now. This evaluation results in the value of the most cited patent from

"Smart Furniture" phrase search represented by 130 million USD. Our evaluation has no ambition to define a unique evaluation method for price determination of patent; thus we are targeting to show a framework with a broader spectrum of evaluation possibilities for the intellectual property represented by granted and valid patent application with citations from other patents. The future direction of our research can be focused on the evaluation of our approach by validation of patent value by the real example of patent or company transfer.

**Acknowledgement.** This work and the contributions were supported by the LTC INTER COST project No. LTC18035 "Evaluation of the potential for reducing health and social expenses for elderly people using the smart environment" by Ministry of Education, Youth and Sports, Czech Republic, COST Action CA16226: Indoor living space improvement: Smart Habitat for the Elderly.

## References

1. Amitay, E., Soffer, A.: Personal index of items in physical proximity to a user, US2005067492 (A1), 31-Mar-2005.
2. Braun, A., Majewski, M., Wichert, R. et al.: Investigating Low-Cost Wireless Occupancy Sensors for Beds, in Distributed, ambient, and pervasive interactions. In: Streitz, N., Markopoulos, P. (eds.) LNCS, vol. 9749, Springer, pp. 26–34 (2016).
3. TechNavio - Infiniti Research Limited. Global smart furniture market 2018-2022 (2018).
4. Hagale, A.R., Kelley, J.E., Rozich, R.: RFID smart office chair, US6964370 (B1), 15-Nov-2005.
5. Hall, B.H., Jaffe, A., Trajtenberg, M.: Market value and patent citations, RAND Journal of Economics, 36(1), pp. 16–38, (2005).
6. Harhoff, D., Narin, F., Scherer, F.M., Vopel, K.: Citation frequency and the value of patented inventions, Review of Economics and Statistics, 81(3), pp. 511–515, (1999).
7. Chen, J.: Novel dining table capable of achieving combined and separate use of mahjong machine and dining table, CN203914053 (U), 05-Nov-2014.
8. Ozick, D.N.: Capacitive sensor systems and methods with increased resolution and automatic calibration, US6661239 (B1), 09-Dec-2003.
9. Patent Value analysis, Patent Inspiration Support. [Online]. Available: <http://support.patentinspiration.com/hc/en-gb/articles/207202943-Patent-Value-analysis>. last accessed: 03-Nov-2018.
10. Song, C. et al.: Novel Quartz Clock with Integrated Wireless Energy Harvesting and Sensing Functions. IEEE Transactions on Industrial Electronics. 1–1 (2018). DOI: 10.1109/TIE.2018.2844848.
11. Tokuda, H.:... Smart furniture: A platform for creating context-aware ubiquitous applications everywhere, in Embedded and Ubiquitous Computing. In: Guo, M., Gao, G. R., Jha, N. K., Yang, L. T. (eds.) LNCS, vol. 3207, , Berlin: Springer-Verlag Berlin, pp. 1112–1112, (2004).
12. Um, T.W. et al.: Trust-Based Resource Sharing Method and System, US2018268473 (A1), 20-Sep-2018.
13. Vaida, C., Gherman, B., Dragomir, M. et al.: Smart Furniture - Quo Vadis. In: Popescu, D. (ed.) proceedings of 2014 International Conference on Production Research – Africa,

Europe and Middle East and 3rd International Conference on Quality and Innovation in Engineering and Management (ICPR-AEM 2014), pp. 493-498, Cluj Napoca, Romania (2014).

14. Von Wartburg, I., Teichert, T., Rost, K.: Inventive progress measured by multi-stage patent citation analysis, *Research Policy*, 34(10), pp. 1591–1607, (2005).
15. Yi Xiaoyang: Furniture Control Method Using Multi-Dimensional Recognition, WO2018023512 (A1), (2018).
16. Zucker, L.G., Darby, M.R., Armstrong, J.S.: Commercializing knowledge: University science, knowledge capture, and firm performance in biotechnology, *Management Science*, 48(1), pp. 138–153, (2002).

## Silver Economy and the Development Policy of Rural Areas in Poland

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**Abstract.** This article is an attempt to assess to what extent *silver economy* may become a development driver of rural areas. In the first part of the paper, attention focused on the scale of population ageing in rural areas and assumptions of silver economy. Hereinafter in the article, selected national strategic documents and programmes are presented and assessed in terms of their usefulness for the implementation of the *silver economy* concept in rural areas. Thus, the aim of the paper is to present and assess the place of various areas of *silver economy* activity in the development policy of Polish rural areas to which the descriptive statistics method was applied. The analysis performed shows that currently in Poland progress has been achieved in operationalisation of activities in the area of *silver economy* at quite a general level – programmes addressed to seniors as the overall community are created. On the other hand, roadmaps are missing for the implementation of senior policy for specific segments of elderly populations inhabiting rural areas where unfavourable demographic situation is particularly visible and where the society ageing process proceeds at a much slower pace than across the country.

**Keywords:** Silver Economy, Society Ageing, Rural Areas.

### 1 Introduction

For years, the ageing society has been perceived as a social problem related mainly to the growing amount of disbursed social benefits and the necessity to develop the health care system and care services. However, the approach to this problem has been changing over the years - obviously, it is different in various countries and depends, for example on the level of their social and economic development, the level of welfare and activity of the society, including the elderly. Within a given country it is also possible to observe diversification of the elderly population - in terms of age, occupation, education, activity and place of residence. More and more attention is paid to the problems of silver economy associated with the elderly population, however, it is still a subject which is not recognised, requiring many studies and adopting specific development scenarios.

This article is an attempt to assess to what extent *silver economy* may become a development driver of rural areas. It is an issue extremely interesting due to the

changing image of the Polish village in terms of social and occupational structure – a decreasing percentage of persons earning their living in agriculture and the evolution of functions fulfilled by rural areas.

## **2 The Aim and Research Methodology**

The aim of the paper is to present and assess the place of various areas of *silver economy* activity in the development policy of Polish rural areas. In order to accomplish this objective, national strategic documents and programmes were selected and assessed in terms of their usefulness for the implementation of the *silver economy*. The base for the selection of documents and programs was primarily the area of regulation and support and the recipients of specific activities. Taking into account these criteria, *Development Programme of Rural Areas for the years 2014-2020* and *National Regional Development Strategy 2010-2020. Regions, cities, rural areas*, as well as a pilot Programme *Active and Healthy Senior Farmer* and *Multi annual Programme "Senior+"* for the years 2015-2020 were considered as particularly important for rural areas. The analyzed documents have a different time horizon, hence their analysis should be treated as a "case study", not a comparative analysis. The time range of research is determined by the date of the introduction and functioning of programs and strategies, however mainly it presents the period of the last few years.

Studying the subject, a critical review of the literature was carried out and the descriptive statistics method was applied. Secondary sources were used to achieve the goal: literature of the subject, national and EU documents and programs, materials made available by public institutions, legal acts.

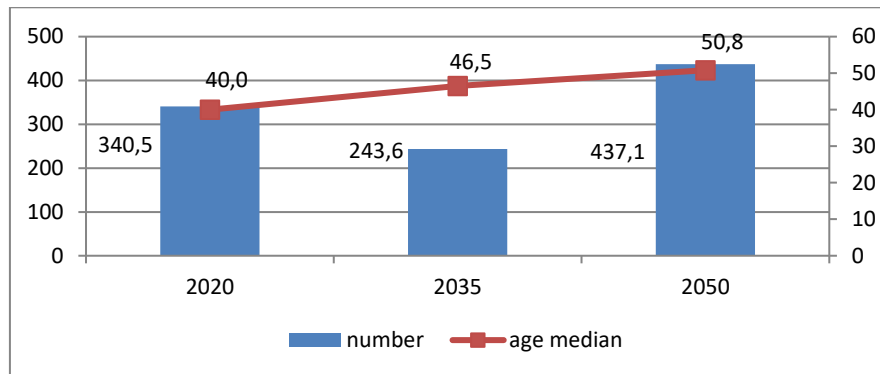
## **3 Development of *Silver Economy* in the Context of Ageing Processes**

In the nearest decades, the Polish society will have to face challenges related to the phenomenon of population ageing. Demographic forecasts clearly indicate the growth of share of the elderly and in accordance with the GUS data, the share of persons aged 65 and more in the total population of Poland in 2050 will reach 30.2%. In the same year, persons aged 80 and more will make 10.4% of the total population (in 2013 – 3.9%) [3]. Population ageing will refer to all communities and a significant growth of the elderly (with a certain decline in the years 2030-2035) will also affect rural areas (Figure 1). Due to the current weakness of the social and technical infrastructure supporting the elderly in rural areas, it triggers a significant risk of increased inequalities.

In accordance with the forecast, a 16.8 pp growth in the percentage of the elderly (+65) in the village is expected and, at the same time, the share of the elderly in the forecast period will exceed 30% of the overall population in rural areas.

The scale of the population ageing processes raises understandable concern associated with the current inefficiency of care systems and inefficiency of the social

security system [10]. On the other hand, a different view of the population ageing phenomenon appears, the view through the perspective of new development opportunities compliant with the *silver economy* concept, where attention is paid to the fact that such processes may become a reason of the “new development path”, without ignoring the risks of the ageing process for the economic growth.



**Fig. 1.** Number of rural population 65+ (in thousand) and age median of village population in the years 2020-2050 [3].

In the OECD document [18] *The Silver Economy as a Pathway for Growth* experts explicitly state that “Several efforts are underway to drive a paradigm shift that views the ageing as assets not liabilities”.

The *silver economy* concept means the economic system oriented towards the adjustment of manufacturing, distribution of goods and services areas to the needs of the ageing population. The *silver economy* concept appeared in the European Union documents as early as at the beginning of the twentieth century, when attention was placed on the fact that ageing of the European population may create an opportunity to increase the competitiveness of the European economy through the production of goods and services addressed to the elderly [5] as well as that the development of innovative enterprises will also enable to expand the development capacity based on global markets since the population ageing problem is becoming characteristic for many non-European countries [4]. In accordance with this approach, the European Commission defines *silver economy* as the existing and emerging economic opportunities arising from the growing public and consumer expenditure related to population ageing and the specific needs of the population over 50 [8].

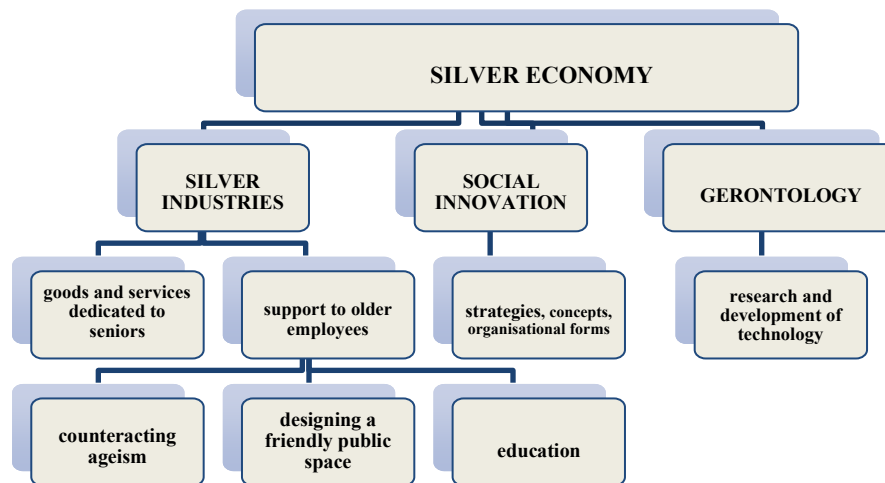
On the other hand, the OECD recognises *silver economy* as silver production, i.e. the economy which produces and delivers products and services targeted at the elderly, developing the environment in which people over 60 cooperate and are successful at work, engage in innovative projects, assist in market development as consumers and lead a healthy, active and productive life [18].

In the Polish literature of the subject, Golinowska [9] uses a very accurate definition of *silver economy* which indicates that *silver economy* involves targeting of supply adequately to changing needs of various groups of the elderly, so that they become a

source of economic activation. Regardless the adopted method of *silver economy* definition, we always deal with representatives of economy undertaking supply activities addressed to the elderly who become beneficiaries in this process. The essence of *silver economy* is not only the positive impact on the quality of life of the elderly. It also means a positive effect on the labour market, allowing for friendly treatment of older employees, better understanding seniors' needs and problems as well as triggering of the creative sector and growth of employment in sectors using the latest technologies. Enste, Naegele and Leve [7] classify, among others, the following industries as those where *silver economy* may stimulate the development of market branches directly and indirectly associated with population ageing:

- information technology (IT) in healthcare,
- adapting dwellings and life facilitating services based primarily on IT,
- independent life based on growing use of IT,
- gerontology areas significant for health economics, including medical technologies and e-health, supporting hearing and sight, prosthetics and orthopaedics,
- education and culture as a response to the willingness to develop and manage free time,
- IT and media linked with medicine, promoting independence and security,
- robotics of services connected with the promotion of independent life in case of elderly persons suffering from severe diseases,
- mobility and promoting its elements, e.g. traffic safety,
- leisure, travel, culture, communication and entertainment,
- fitness and wellness as a response to trigger the awareness of a healthy lifestyle;
- clothing and fashion as a symptom of strive for social integration,
- services facilitating daily operations and other household works,
- insurance referring mainly to risk forms typical for the elderly,
- financial services, in particular in the area of capital protection, wealth preservation and prevention of savings loss.

Taking into account the diversified (but containing common elements) way of *silver economy* understanding, its holistic dimension may be adopted, as indicated in Figure 2.



**Fig. 2.** Areas of *silver economy* activities.

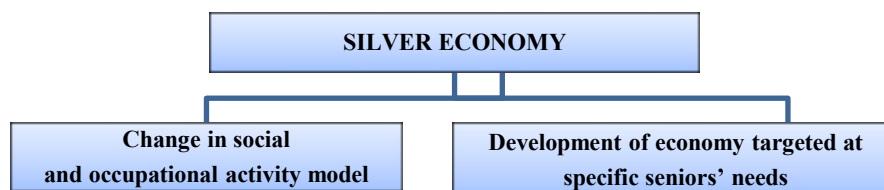
The figure shows a multi-purpose area of *silver economy* implementation, comprising both products and services dedicated to the seniors and including such issues as: strengthening social cohesion, inclusion and social participation of the seniors, supporting and propagating their participation in the labour market, propagating seniors' activity and health and their independent life as well as research and innovation aiming at improvement of life of the elderly. Such approach to the areas of *silver economy* activities fully implements the assumptions indicated by the Council of the European Union [6].

The significance of *silver economy* development in rural areas is enormous since it demonstrates greater difficulties in the access to care services and social infrastructure which would facilitate functioning of seniors living there compared to urban areas. The current state of affairs is not satisfactory and the development of *silver economy* is the opportunity to reduce inequalities in the access, among others, to care services, to increase the multifunctional character of rural areas as well as to enhance broadly understood economic development.

The implementation of *silver economy* must also take into account the fact that the community of the elderly is not homogeneous. The seniors differ between each other in many ways - both due to features of social diversification characteristic for the society as a whole (economic status, social status, social and cultural capital held, gender, physical and mental condition) as well as differentiation due to age. The reason is that needs of persons 60+ are different than those of 90+ persons - more differences than similarities can be found among them. Thus, in order to respond in an adequate way to the seniors' needs and to achieve economic and social successes, heterogeneity of the senior community should be taken into account. Thus, the issue of building regional development strategies becomes essential, where direct activities targeted at and addressed to seniors will have a significant share. Therefore, in the development of



silver economy in rural areas it is essential to focus attention on two development paths presented in Figure 3.



**Fig. 3.** *Silver economy* development paths in rural areas.

Outlining general directions of *silver economy* for the country, forming a part of the European Union assumptions in this area becomes important. Possibilities of implementation of the general assumptions should arise from the specific nature of the particular region, character of the municipality, they should be adjusted to local needs in the scope of support of various areas of seniors' functioning, they should also take into account financial capacity and resources of entities responsible for activities and participating in the implementation of projects.

#### **4     *Silver Economy* in Selected National Strategic Documents**

The policy related to ageing of societies refers to many areas of support, such as employment, equality of opportunities in the access to products and services, innovation, education or broadly understood care. Determining the priority directions of actions and the analysis of possibilities for their implementation and support is required in the case of *silver economy*, to which attention started to be paid and whose significance in the country started to be emphasised relatively recently. Elements required for its effective development include: coordination of various policies, cooperation between bottom-up and top-down initiatives, consistency of strategic documents, multi-level shared management, integration and reorganisation of public services towards the development and co-production of services with citizens or dialogue between local communities and administration [11]. In accordance with the classification of welfare state models proposed by Yuri Kazepov, Poland belongs to the model comprising the majority of countries of Central and Central-East Europe (undergoing system transformation) demonstrating social policy reform occurring under the conditions of financial limitations (generating ambivalent effects), and implementation of significant reforms of territorial administration oriented to decentralisation of social benefits and services - often triggering further deepening of regional and local differences [11]. Under such conditions, adequate programmes and strategies are required, in particular in the context of signalling and initiating measures necessary for the proper functioning of seniors in the future.

Strategic national strategic documents significant in terms of *silver economy* include:

- *Governmental Programme on Social Activity of the Elderly for the years 2014–2020* – aimed at improvement of the quality and level of life of the elderly for ageing based on dignity through social activity, taking into account the internal diversity of the elderly population [20],
- *Assumptions of the Long-term Senior Policy in Poland for the years 2014–2020* - constituting the specific set of necessary activities in the area of senior policy in Poland, addressed to a wide target group: the society, public authorities at all levels, private sector and NGOs as well as social partners [21],
- *Solidarity of Generations Programme. Activities to increase occupational activity of persons aged 50+* - comprising a broad spectrum of initiatives aimed at better use of human resources of persons aged 50 and more [22],
- *Long-term Development Strategy for the Country “Poland 2030. Third Wave of Modernity”* – where the growth of social development capital was adopted as objective 11 and one of intervention directions focused on the preparation and introduction of the civic education programme at all levels of education, in the perspective of life-long learning [12],
- *Human Capital Development Strategy* – taking into account human capital building throughout the entire life cycle, including at the stage of occupational activity, adult learning and parenthood as well as old age [19],
- *Multi annual Programme “Senior+”* for the years 2015-2020 (in 2015-2016 – *Multi annual Programme “Senior – WIGOR”*) – the aim of which is to increase active participation of seniors through co-financing of local government entities in the development of a network of “Senior+” Day Centres and “Senior+” Clubs on their territory [17],
- *Programme “Care 75+”* for the years 2015-2020 – aimed at improvement of access to care services and specialised care services to lonely elderly persons aged 75 and more [14].

The majority of strategic documents contains proposals of measures addressed to and targeted at the seniors, treating this community as a whole or taking into consideration the internal diversification of this population, however, the differentiation of projects from the point of view of “seniors in cities” and “seniors in rural areas” can be hardly seen. Therefore, an attempt aimed at placement and assessment of the senior policy importance in examples of the programmes is undertaken below, taking into account the space of residence.

## **5 Silver Economy in Selected Documents and National Programmes Addressed to Rural Areas**

One of the strategic documents taking into account the criterion of space is the *National Regional Development Strategy 2010-2020. Regions, cities, rural areas*. This Strategy takes into consideration the territorial diversification of potentials, including the social capital, identifying as its strategic objective the “effective use of regional and other territorial development potentials to achieve the aim of country development - growth,

employment and cohesion in a long-term timeframe” [16]. Although measures addressed strictly to 50+ persons are not taken into account in the document, nevertheless, the necessity of special treatment of those rural areas which have the worst access to public services determining development opportunities was indicated. Activities implementing the strategic objective of the *National Regional Development Strategy*, with positive impact on the development of rural areas included, among others, measures increasing transport availability, development of institutions of business environment, horizontal activities in the scope of human, intellectual and social capital. These measures indirectly determine functioning and development of the seniors in rural areas, affecting the shape of the labour market, availability of services and educational opportunities.

It seems that the programme which - due to its designation - should consider the needs of the ageing society of the Polish village to a largest extent is the *Development Programme of Rural Areas for the years 2014-2020*. Unfortunately, measures directly addressed to the 50+ target group can be hardly found in it - in fact, this group of beneficiaries can be seen in two specific objectives of the Programme: within Priority 1: *Facilitating the transfer of knowledge and innovation in agriculture, forestry and in rural areas*, objective 1C: *Supporting long-life learning and vocational training in the agricultural and forestry sectors* and within Priority 6: *Promoting social inclusion, reduction of poverty and economic development in rural areas*, objective 6B: *Supporting local development in rural areas*. The local development comprises, among others, the construction or modernisation of local roads, it means, the measure fostering undertaking employment outside the place of residence or use of public services comprising education, health or culture [13]. The vast majority of measures supported under the PROW comprises occupationally active farmers - obviously, persons aged 50+ may also use other measures related to the growth of competitiveness, modernisation of farms, improvement of the quality of products, nevertheless - as Poland's experience in the implementation of the programme in previous programming periods shows - these projects are mainly implemented by younger agricultural producers. Undoubtedly, the Programme contains a limited number of measures addressed to inhabitants of the village other than farmers and to persons from higher age categories. This confirms the aforementioned fact of the relatively short interest in *silver economy* problems in Poland and the failure to take it into account in many currently valid documents.

Although the issue of life quality of the seniors in rural areas requires a greater involvement of various social groups, the problem is more and more commonly noticeable, similar to the progress in implementing various solutions. An example is a pilot Programme *Active and Healthy Senior Farmer* - a project launched by the Agricultural Social Insurance Fund (KRUS), the Farmer Social Insurance Contribution Fund and the Polish Public Health Association in April 2018. The Programme was created as a result of search for innovative solutions comprising the organisation and provision of care services, rehabilitation and health prophylaxis among farmers, taking into account the accident risk in agriculture, diseased typical for the older age and the specific character of the agricultural work [1]. *Active and Healthy Senior Farmer* assumes, among others, complex day care with elements of rehabilitation, complex

stationary rehabilitation, short-term stays with accommodation for the elderly, combined with rehabilitation – within the support of caretakers of the elderly, e.g. in the period of intensified works on a farm [2]. The prerequisite for participation in the programme is holding the KRUS insurance.

One of the programmes addressed, among others, to seniors inhabiting rural areas is the aforementioned *Multi annual Programme “Senior+”* for the years 2015-2020. Its beneficiaries include local government units, including rural communes whereas the seniors represent the ultimate target group, with the financial support allocated for the improvement of their life quality. The outcomes of the implementation of the “Senior+” Programme in rural areas up to date are presented in Table 1.

As the table shows, the number of communes which used the opportunity to participate in the “Senior+” Programme is not impressive (over 2100 rural communes and rural-urban communes exist in Poland), especially that some entities which were granted the support in the first years of the Programme functioning for establishment of the Senior Day Care Centre or Senior Club, also applied in the subsequent years for the purpose of ensuring the functioning of those facilities (repeatability of beneficiaries).

**Table 1.** Support to rural communes (R) and urban-rural communes (U-R) under the Multi annual Programme “Senior+” The advantages of social farming [15].

Module	Number (R) and (U-R) // percentage of the total number of beneficiaries of the module	Number of places in facilities	Amount of subsidy (PLN)
<b>“Senior-WIGOR” Programme (2015-2016)*</b>			
“Senior-WIGOR” day care centres	(R): 30 // 25.2% (U-R): 41 // 34.5%	- -	6,630,847.57 9,186,658.13
<b>“Senior-WIGOR” clubs</b>			
<b>“Senior-WIGOR” Programme (2017-2018)</b>			
Establishing or furnishing of the “Senior-WIGOR” day care centre	(R): 38 // 38.0% (U-R): 28 // 28.0%	891 612	8,813,625.26 6,453,653.03
Establishing or furnishing of the “Senior+” club	(R): 126 // 54.8% (U-R): 51 // 22.2%	2951 1297	15,293,372.19 5,748,351.25
Provision of functioning of “Senior+” – Day Care Centre facilities	(R): 45 // 28.9% (U-R): 55 // 35.3%	891 1264	2,829,416.05 3,952,134.99
Provision of functioning of “Senior+” – Senior Club facilities	(R): 31 // 41.3% (U-R): 28 // 37.3	610 770	804,304.83 806,538.63

\* Lack of data across the modules and information concerning the number of places in the facilities.

So far, rural communes showed the greatest interest in the possibility to establish or equip a “Senior+” Club, the activity of which involves motivating the seniors to

undertake self-aid and voluntary activities (over a half of the overall number of beneficiaries of this Programme module).

## 6 Conclusion

In face of the current demographic tendencies, the implementation of *silver economy* assumptions seems necessary. The earlier the potential of the seniors is recognised, the greater development benefits may the national or regional economy gain. It seems that currently in Poland progress has been achieved in operationalisation of activities in the area of *silver economy* at quite a general level – programmes addressed to seniors as the overall community are created. However, roadmaps are missing for the implementation of senior policy for specific segments of elderly populations distinguished due to, for example, their place of residence, age groups, level of wealth, health condition. An example may be the group of seniors inhabiting rural areas which has so far been hardly addressed in strategic documents and programmes, which is in a more difficult situation in many respects (e.g. access to specific goods and services) than inhabitants of cities. Much more attention should be definitely paid to seniors in rural areas, which is determined by the contemporary image of the Polish village - the senior care model based on the multi-generation family is not as popular as before and agricultural population does not prevail in each village.

As results from the conducted research, the *silver economy* is implemented in rural areas mainly through the inclusion and social participation of seniors and strengthening social cohesion, in which areas the Senior Club plays a major role. Little progress has been observed so far in promoting seniors' activity and health, or promoting their participation in the labor market. It is also difficult to break up in the Polish countryside with the tradition of staying only in their own environment, which limits access to many goods and services dedicated to seniors, but offered at regional rather than local level. Therefore, it is necessary to reach out to residents of rural areas aged 50 who with their senior products and services which make a huge market for them.

Participation in programmes enabling to acquire support for the implementation of tasks related to senior care is usually voluntary, therefore, it requires mainly the awareness of the usefulness of activities of this type. Rural communes should perceive the necessity to join various pro-senior programmes - although still not numerous, however, functioning - due to the fact that the unfavourable demographic situation is particularly visible in small communes where the process of society ageing proceeds at a much faster pace than across the country, and difficulties in providing care services are particularly visible.

## References

1. Active and Healthy Senior Farmer – the conference launching the pilot KRUS Programme, Warsaw, 2018, <https://www.krus.gov.pl/aktualnosci/dokument/arttykul/aktywny-i-zdrowy-senior-rolnik-konferencja-inaugurujaca-pilotazowy-program-krus/>, last accessed 2018/08/16.

2. Active and Healthy Senior Farmer, <http://ksow.pl/news/entry/13209-aktywny-i-zdrowy-senior-rolnik.html>, last accessed 2018/08/16.
3. Central Statistical Office: Population forecast for 2014-2050. Warsaw (2014).
4. Commission of the European Communities: Dealing with the impact of an ageing population in the EU (2009 Ageing Report) (COM(2009 180 final). EU COM, Brussels (2009).
5. Commission of the European Communities: The Demographic Future of Europe – from Challenge to Opportunity (COM(2006) 571 final). EU COM, Brussels (2006).
6. Council Declaration on the European Year for Active Ageing and Solidarity between Generations, Brussels, 7 December 2012, 17468/12, <http://register.consilium.europa.eu/doc/srv?l=PL&f=ST%2017468%202012%20INIT>, last accessed 2018/03/14.
7. Enste, P., Naegle, G., Leve, V.: The Discovery and Development of the Silver Market in Germany. In: Kohlbacher, F., Herstatt, C. (eds.) *The Silver Market Phenomenon. Business Opportunities in an Era of Demographic Change*, pp. 330-331. Springer, Heidelberg. (2008).
8. European Commission: The 2015 Ageing Report: Economic and budgetary projections for the EU 28 Member States (2013–2060). *European Economy*, no 3, pp. 1-424. Luxembourg (2015).
9. Golinowska, S.: Silver economy - an element of regional development strategy. *Małopolskie Studia Regionalne*, no 2-3, pp. 31-32. The Marshal's Office of the Małopolska Region, Kraków (2014).
10. Iwański, R.: Long-term care after the elderly. *CeDeWu.pl*, Warsaw (2016).
11. Klimczuk, A.: "Silver economy" models in the European Union in comparative terms: an attempt to introduce the discussion. *Problemy Zarządzania*, no 14/2 (1), pp. 41-59. University of Warsaw, Warsaw (2016).
12. Ministry of Administration and Digitisation: Poland 2030. Wave of Modernity. Long-term Development Strategy for the Country. Warsaw, 11 January 2013, [http://www.kigeit.org.pl/FTP/PRCIP/Literatura/002\\_Strategia\\_DSRK\\_PL2030\\_RM.pdf](http://www.kigeit.org.pl/FTP/PRCIP/Literatura/002_Strategia_DSRK_PL2030_RM.pdf), last accessed 2018/08/16.
13. Ministry of Agriculture and Rural Development: Development Programme of Rural Areas for the years 2014-2020, Warsaw, 2014, <https://www.gov.pl/rolnictwo/-program-rozwoju-obszarow-wiejskich-2014-2020-prow-2014-2020>, last accessed 2018/08/16.
14. Ministry of Family, Labour and Social Policy: Programme "Care 75+" 2018 (amendment), Warsaw, <https://www.mpips.gov.pl/seniorzyaktywne-starzenie/program-opieka-75/>, last accessed 2018/08/21.
15. Ministry of Family, Labour and Social Policy: Results of open competitions for offers under the Multi annual Programme "Senior+" for the years 2015-2020. Issue 2015-2018, <https://www.mpips.gov.pl/seniorzyaktywne-starzenie/program-senior/>, last accessed 2018/08/21.
16. Ministry of Regional Development: National Strategy of Regional Development 2010-2020. Regions - cities - rural areas. Warsaw (2010).
17. Multi annual Programme "Senior+", Annex to Regulation No 157 of the Council of Ministers of 20 December 2016 (item 1254), <https://www.mpips.gov.pl/seniorzyaktywne-starzenie/program-senior/program-senior-/>, last accessed 2018/08/21.
18. OECD: University of Oxford, Global Coalition for Ageing, The Silver Economy as a Pathway for Growth. Insights from the OECD-GCOA Expert Consultation, 26 June 2014, <https://www.oecd.org/sti/the-silver-economy-as-a-pathway-to-growth.pdf>, last accessed 2018/07/10.
19. Resolution No 104 of the Council of Ministers of 18 June 2013 concerning the adoption of the Human Capital Development Strategy 2020, *Monitor Polski*, Warsaw, 7 August 2013, item 640.

20. Resolution No 237 of the Council of Ministers of 24 December 2013 concerning establishing of the Governmental Programme on Social Activity of the Elderly for the years 2014–2020, Monitor Polski, Warsaw, 24 January 2014, item 52.
21. Resolution No 238 of the Council of Ministers of 24 December 2013 concerning adoption of the document: Assumptions of the Long-term Senior Policy in Poland for the years 2014–2020, Monitor Polski, Warsaw, 4 February 2014, item 118.
22. Resolution No 239 of the Council of Ministers concerning establishing of the Solidarity of Generations Programme. Activities to increase occupational activity of persons aged 50+, Monitor Polski, Warsaw, 4 February 2014, item 115.

## The Prediction Ability of New Bankruptcy Models in National Environment

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**Abstract.** The prediction of the firm's future development and possible failure is one of the most important information needed for decision making by all stakeholders. Early detection of impending bankruptcy creates the possibility of adopting remedial measures that can, if they are effective, avert it. The crisis in recent years has raised the focus on predictive models and their reliability. In response to the experience with the elder models and their lower reliability the researches aimed to construct new versions of the older models as well as the new models based on the wider scale of variables. One of the stream of researches is aimed to construct specific models for the condition of emerging economies, i.e. Polish, Slovak, Lithuanian and Czech environment.

The aim of this paper is to compare the reliability of selected foreign bankruptcy models in the conditions of the Czech economy compared to the Czech model and to reveal if there are any differences in the prediction ability depending on the conditions under which they were compiled. We used a set of 80 Czech companies operating on the Czech market, in which insolvency was declared in 2017. Based on these data we compare the prediction ability of the selected models which were created in the foreign economies, both traditional economy and emerging. The results did not confirm the greater reliability of the model that was created in national conditions. The most reliable model has been identified the one created in terms of another transition economy.

**Keywords:** Bankruptcy Models, Prediction Accuracy, Transition Economy.

### 1. Introduction

In the contemporary dynamic economic environment, the prediction of the future development and an early identification of possible failure in the future is very important and usable information for all stakeholders. Consequently, many researchers are making considerable efforts, on the one hand, to create new, more advanced models to provide this information as reliably as possible, on the other hand they turn the attention to the models that have already been created and verify their prediction ability at present conditions and in different economies. The result of these studies is the finding that the reliability of predictions of individual models is lower if they are applied in a different environment and different time than they were created [9, 17, 4, 21, 15, 7, 14]. These findings stimulate further research activities aimed to develop new models, appropriate for the time and the conditions in which they are to be used. The result of these activities



is a number of new models that are geared to the specific conditions of each economy or period, e.g. for Czech, Polish, Slovak, Lithuanian environment [5], or the new version of the former models, e.g. Altman's model for the UK, the version of the Ohlson's model 2010 for China or 2011 for Iran [20, 23], etc. Their prediction ability has been tested, both in the conditions in which they originated and in the context of the other economies. Another problem is whether the models created within these conditions achieve higher reliability of prediction in terms of a transition economy compared to models created in traditional market economies. This became a research question in this study. The aim is to verify if the predictive ability of the models created under the conditions of transition economies is larger in the similar condition compared to the model created in the traditional market economy or to the model of domestic origin. It can be supposed, that the model derived from the condition of the transition economy can assess the situation of enterprises in the same condition more precisely and will show a higher reliability in prediction.

The structure of the paper is as follows: in the next chapter a literature review and the used method are described, in the third part the models and the set of firms are characterized, in the fourth part the results of all the models are presented and compared. In the last part the conclusion is presented and the questions for further research are formulated.

## **2. Previous Literature**

The bankruptcy model and its construction involve many issues and sub-issues and many questions need to be solved before and during the process of its derivation. The primary question may be the ones as follows: when the moment is the company fall into the failure, what are the reasons and what are the signs of the failure (according the legal regulation and in real practice), when the firm is forced to close their activities. With the aim to predict the failure the other questions arise: what factors influence the firm activities and may be the cause the firm's failure, what phenomena indicate the financial problems ahead of the year or two in advance. These factors can be both financial and non-financial, both external and internal, both quantitative and qualitative.

The other questions are focusing on the data source, which can provide a general statement about the company's processes and its financial situation and its ability to sufficiently reflect the future failure. The most common source of data appropriate for these purposes the financial statements have become. But the financial statements provide only financial data that is more or less influenced by the accounting methods. The other data sources, non-financial and qualitative, are highly differentiated.

In the process of the model creation the other specific question concerning the mathematical method used for deriving the predictive models is the key. The classification of these methods varied: the discriminatory models, discriminant analysis and logistic regression or GLM models and Merton model [22, 8] are most often distinguished. Some authors suggest using methods of neural networks as a new tool for model derivation [12, 6]. The choice of method is decisive for model derivation - it can determine its reliability and accuracy [10, 11]. Till now the most often method used for

the bankruptcy model's construction was the multivariate discriminant analysis (MDA) although some weaknesses and limitations are known. Despite this, it remains the most commonly used method for construction of the new models.

At the first step the structure of models under investigation will be described. We chose models created in the United States, in Australia, in Poland, in the Czech Republic, and in Lithuania, which are often used in practice, namely: Altman model for nonlisted companies (1983), Ohlson's model (2010), Gajdka and Stos 2 (1996), IN05 (2005), Hybrid SOM-Altman model (2006). Then we investigated whether the aforementioned models could indicate one or two or three years before the reported bankruptcy the future threat. The most reliable model then was identified, and the limitation of the findings will be discussed.

### 3. Data set and Methodology

The methodology of our research consists in the application of selected models on the set of Czech companies that got into serious financial difficulties in the year of 2017. As a moment of serious financial difficulties, the announcement of insolvency is considered in this study. The information about the firms with which the insolvency proceedings were commenced we gathered from the Insolvency register. Then we tried to find the financial statements of these companies from the Commercial Register. Even though the firms in the Czech Republic are obliged to publish their financial statements in the Commercial Register every year, this obligation is often not respected, even more by those companies that have been in a difficult situation. However, a group of 80 companies with financial statements available for all three years before the announcement of insolvency were found. The structure of companies in the set of firms according the SMEs parameters including the values of these parameters are shown in the Table 1.

**Table 1.** Structure of the set of 80 analyzed firms that have fallen into insolvency in 2017.

(in CZK)	Micro	Small	Medium	Large	Total
Total assets less than	9 mils.	100 mils.	500 mils.	More than 500 mils.	x
Turnover less than	18 mils.	200 mils.	1 000 mils.	More than 1 000 mils.	x
Employees less than	10	50	250	More than 250	x
Number of companies	53	26	1	0	80

The choice of the models for testing follows the intention to verify the prediction ability of the models created under different national conditions in conditions of the Czech Republic as a transition economy. The selected models were as follows:

- Altman Z-score for nonlisted companies – that is the original Altman model modified in 80th for non-listed companies. The original model was derived from US business data and US economic conditions in 70th. The adjustment consisted of the fourth indicator - after this adjustment, the calculation is based on this relationship (1):

$$Z' = 0.717*X1 + 0.847*X2 + 3.107*X3 + 0.420*X4 + 0.998*X5 \quad (1)$$

where:  $X1$  – net working capital/total assets;  $X2$  – accumulated earnings/total assets;  
 $X3$  – EBIT / total assets;  $X4$  – equity / liabilities;  $X5$  – sales / total assets.

Interpretation of the model results:

Z-score > 2.9 - not current threat of bankruptcy, ,

Z-score < 1.8 - serious financial difficulties,

Z-score in the interval of 1.8 to 2.9 - a grey zone, no prediction is possible.

- Model IN05 – this is a model created based on the conditions and accounting data of Czech firms at the beginning of the century. The authors used the experiences in creating the previous models. The calculation of this model is based on the following relationship (2):

$$IN05 = 0.15*X1 + 0.04*X2 + 3.97*X3 + 0.21*X4 + 0.09*X5 \quad (2)$$

where:  $X1$  – total assets / liabilities;  $X2$  – EBIT / interests;  $X3$  – EBIT / total assets;  
 $X4$  – sales / total assets;  $X5$  – current assets / short-term liabilities.

Interpretation of the resulting values:

IN05 < 0.9 – companies are running for bankruptcy with a probability of 97% and with the probability of 76 per cent they will not generate the value,

0.9 < IN < 1.6 – companies are with a probability of 50 per cent likely to fail and with the probability of 70 per cent they will not generate the value,

IN05 > 1.6 – companies are with the probability of 92 per cent in a good condition and with the probability of 95 per cent they are likely to generate the value.

- Ohlson's model 2010 – is the original Ohlson's model recalculated by economists at the Australian University of Queensland with the aim of finding new weighting coefficients along with verification of some new indicators. This modified model was based on a much larger sample of companies and on the data from a relatively long period from 1980 to 2006. The calculation of this model is based on the formula (3):

$$Q = -0.17*X1 + 3.69*X2 - 1.87*X3 + 0*X4 - 0.54*X5 + 0.03*X6 - \\ - 0.06*X7 + 1.16*X8 - 1.02*X9 - 7.2 \quad (3)$$

The indicators  $x_1, \dots, x_9$  included in the model are constructed as follows:

$$X_1 = \log \frac{\text{total assets}}{\text{GNP price-level index}};$$

$$X_2 = \frac{\text{total liabilities}}{\text{total assets}};$$

$$X_3 = \frac{\text{working capital}}{\text{total assets}};$$

$$X_4 = \frac{\text{current liabilities}}{\text{current assets}};$$

$$X_5 : X_5 = 1, \text{ if total liabilities} > \text{total assets}; \quad X_6 = \frac{\text{net income}}{\text{total assets}};$$

$$X_5 = 0, \text{ if total liabilities} < \text{total assets}$$

$$X_7 = \frac{\text{funds provided by operations}}{\text{total liabilities}}$$

(where: funds provided by operations = net income + depreciations / amortizations);

$$X_8 : X_8 = 1, \text{ if the sum of net income for the two previous periods is less than } 0$$

$$X_8 = 0, \text{ if the sum of net income for the two previous periods is more than } 0;$$

$$X_9 = \frac{NI_t - NI_{t-1}}{|NI_t| - |NI_{t-1}|} \quad (\text{where: } NI_t \text{ is the net income for the current period and } NI_{t-1} \text{ is the net income for the previous period, } |NI_t| \text{ and } |NI_{t-1}| \text{ are the absolute values of the net income for current / previous period}).$$

Resulting variable Q is only an interim result that must be applied in the probability calculation relationship (see Formula (4) ):

$$P = (1/(1 + e^{-Q})) \quad (4)$$

The resulting value (P) of the model describes the probability that bankruptcy for the company being analyzed occurs with a predetermined period of time (i.e. one year, two years, or five years). It may have different values from the interval of (0; 1). The probability calculation also suggests that the higher is the value Q, the higher is the propensity to bankruptcy; on the other hand, low Q values characterize stable situation:

- If  $Q < 0$ , then  $P \rightarrow 0$  (P converges to 0);
- If  $Q > 0$ , then  $P \rightarrow 1$  (P converges to 1);
- If  $Q = 0$ , then  $P = 0.5$ .

- Model Gajdka and Stos 2 – is the first model adapted to the conditions of the transition economy (in Poland), it was originally created by the authors in 1996. The reliability of the correct prediction for this model was verified in 82.5 per cent. The calculation is based on the following relationship:

$$PG = S - X1*0.0856425 + X2*0.000774 + X3*0.220985 + X4*0.6535995 - X5*0.594687 \quad (5)$$

where:  $S$  – constant value +0.7732059;

$X1$  – sales / total assets;  $X2$  – shortterm liabilities \* 365 / operating costs;

$X3$  – EAT / total assets;  $X4$  – EBIT / sales;  $X5$  – liabilities / total assets.

Interpretation of resulting values:

There is only one value (PG – Punkt graniczny) of +0.45 to predict financial distress. If the resulting value PG is higher, the company is not going to bankruptcy, if it is lower it indicates the company's future financial distress.

- Hybrid SOM-Altman model - this is an exceptional model by linking Altman's original model and neural network mathematical model (more specifically the artificial neural network - self-organizing map). Application of neural networks to prediction models is often considered as the fourth developmental stage of the models. This model was created at the University of Lithuania in 2006 by E. G. Garšva and S. Girdzijauskas. The impetus to this step was the fact, that the predictive reliability of the Altman's Z-score for private unlisted enterprises in the condition of the Lithuanian market was very low. Therefore, they linked it with a neural network model tested on the NASDAQ list and a new Z-Score formula with modified weights was formed. It was proved as much more suitable for the conditions of the Lithuanian economy. The authors report a change in the prediction ability of the previous Altman model from 72.68 to 92.35 per cent. Its calculation is based on the formula (6):

$$Z' = 0.717*X1 + 0.843*X2 + 2.800*X3 + 0.440*X4 + 0.400*X5 \quad (6)$$

where:  $X1$  – net working capital/total assets;  $X2$  – accumulated earnings/total assets;

$X3$  – EBIT/total assets;  $X4$  – market value of equity/liabilities;

$X5$  – sales/total assets.

Interpretation of the resulting values:

There is only one value for the final score of 1.8. When the firm's resulting value is lower than 1.8 the bankruptcy can occur. If it is higher than 1.8 the company is assessed as seamless with a good financial condition. There is no interval of the grey zone where the prediction is not possible.

#### 4. The Results and Interpretation

Based on the five models the final model values were calculated for all the firms in the set for three, two and one year before the initiation of insolvency proceedings. The results of bankruptcy predictions of all the models are presented in the Table 4. The number of firms were not the same in all the years due to the incompleteness of the data needed for the calculation.

**Table 2.** Results in bankruptcy prediction of analysed models.

Years before the bankruptcy	-3		-2		-1	
<i>Model and its results</i>	<i>abs.</i>	<i>in per cent</i>	<i>abs.</i>	<i>in per cent</i>	<i>abs.</i>	<i>in per cent</i>
<b>Altman's model</b>						
Number of firms in the set <sup>1</sup>	80	100	80	100	77	100
Threat of bankruptcy	33	41.25	30	37.50	37	48.05
Grey zone	28	35.00	26	32.50	16	20.78
Good condition	19	23.75	24	30.00	24	31.17
<b>Model IN05</b>						
Number of firms in the set	80	100	80	100	76	100
Threat of bankruptcy	43	53.75	40	50.00	42	55.26
Grey zone	18	22.50	18	22.50	21	27.63
Good condition	19	23.75	22	27.50	13	17.11
<b>Ohlson's model</b>						
Number of firms in the set	79	100	79	100	75	100
Threat of bankruptcy	14	17.72	21	26.58	22	29.33
Good condition	65	82.28	58	73.42	53	70.67
<b>Gajdka and Stos model</b>						
Number of firms in the set	77	100	75	100	67	100
Threat of bankruptcy	57	74.03	58	77.33	52	77.61
Good condition	20	25.97	17	22.67	15	22.39
<b>SOM-Altman model</b>						
Number of firms in the set	80	100	80	100	77	100
Threat of bankruptcy	63	78.75	57	71.25	56	72.23
Good condition	17	21.25	23	28.75	21	27.27

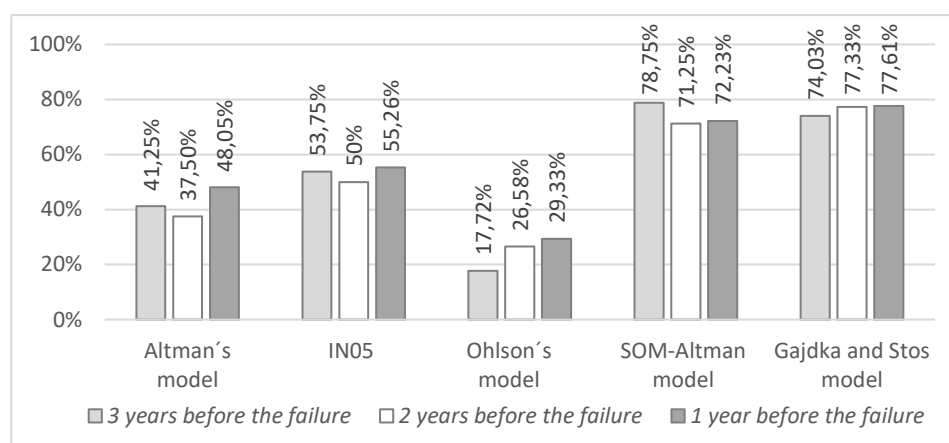
The most reliable models in the prediction were Gajdka and Stos model and SOM-Altman model that predicted failure with an accuracy more than 75 per cent of companies in all the three years before the failure. The share of correct predictions slightly increased with the upcoming the year of failure. Z-score and IN05 models have shown relatively low

reliability. Their forecast of the future failure was around 50 per cent. Significantly worse reliability was shown in case of the Ohlson's model which predicted the future problems only in 17-22 per cent of companies.

A comparison of the results of all analyzed models is present in Table 5 and shown in Figure 1.

**Table 3.** Comparison of the results in the bankruptcy prediction of all the models

Years before the bankruptcy	-3	-2	-1
<i>The share of correct prediction</i>	<i>in per cent</i>	<i>in per cent</i>	<i>in per cent</i>
Altman's model	41.25	37.50	48.05
IN05	53.75	50.00	55.26
Ohlson's model	17.72	26.58	29.33
Gajdka and Stos model	74.03	<b>77.33</b>	<b>77.61</b>
SOM-Altman model	<b>78.75</b>	71.25	72.23



**Fig. 1.** Comparison of prediction ability of analysed models in the one, two and three years before the failure.

## 5. Discussion

Performed calculations and comparisons of the predictive reliability of the five selected models showed that the models quite significantly differ in the ability to predict the firms' failure. Two models have proved to be significantly more sensitive and more reliable than three others. These models are the Gajdka and Stos model and the SOM-Altman model, i.e. Polish and Lithuanian models. Both the models were derived based on the data and conditions of the emerging economy, one of them with the new method use for its derivation. The success rate of the other models was relatively lower. Even in case of the IN05 model that has been derived from the Czech conditions as a transit economy and

now was used in the same conditions. The share of its correct prediction was about 50 per cent. The lowest prediction ability was found in case of Ohlson's model 2010.

These results arise a lot of questions however they can't be answered based on the knowledge gained till now. Both the successful models were created under the conditions and for the conditions of transition economy. It can be considered as a reason of the higher reliability in the similar conditions of Czech firms. But one of these successful models was created using a new method, not yet used for predictive modeling (neural networks). And the share of correct predictions was the same as the other one based on the standard methods. This may lead to a simplified conclusion that the new method of model derivation is not a significant factor in the reliability of the prediction. But this finding cannot be unambiguously declared and must be verified in the next research in different conditions.

The explanation of the higher reliability in prediction of both the two models as well as the effects of the new method of derivation of the model will be also a question for further research. One of the reasons can be seen in the data and in the accounting standards which underlie the accounting data as a base for the model derivation and as a base for its application. The unambiguous conclusion the further follow-up research will allow.

The reliability of the two models' predictions differed depending on the time before bankruptcy. It increases slightly with the approaching failure time for both models. But the increase was relatively slight. In case of SOM Altman model the highest rate of correct prediction was three years before the failure while the two years before it was lower and one year before failure it was slightly increasing. In case of the Gajdka and Stos model the highest rate of correct prediction was in the last year before the failure. To find out the reason could also bring subsequent research in the other conditions and different time.

## **6. Conclusions**

The performed comparison of the ability of the selected models to recognize the upcoming financial problems in time turns the attention to the many areas of the predictive model construction: to the specific conditions of its derivation, to the methods used of its derivation, to the financial data as a base of its derivation as well as of its application as to the reason of the models' reliability. As an important reason can be seen the specific economic conditions in which the model was derived. At the same time the results turn the attention to the time of the model creation: model IN05 even if it was derived in the Czech conditions, but the relatively long time ago and in the rapidly changing conditions of the transition economy may have already lost its distinctiveness. But this conclusion can be confirmed in the next research carried up in the other national conditions and using the other models.

The financial data which are the main source for both the derivation and the calculation of the models have its own national feature. The role of accounting data and accounting rules in the predictive ability and reliability of the models still remains in the background of the researchers' attention. The accounting principles and methods affect the data across accounting statements. They are not only different in different national environments, but also within the national environment itself (as a result of options in the financial reporting

regulation). The attitude to the information ability and usefulness of financial statement is the result of long time development and these historical roots affects the current access to the creation, quality and use of accounting data. It can be the reason of the different or the same prediction ability of the models originating from the different environments. These aspects may also be the subject of the following research.

Based on the results it can be concluded that the assumption of this research project has been confirmed, albeit only in part and not entirely unambiguously. The model derived from the same economic conditions (IN05) as the analyzed companies did not show a higher level of reliability compared to models derived from different economic conditions. The reasons may be in the time of its derivation, in the data used for its derivation etc. Striving for a more precise answer can be an incentive for further research projects.

**Acknowledgements.** This paper was prepared with the support of Research project IGA VŠFS 7429 “Integrated reporting and its place in condition of business in CR” funded by the institutional support for long-term strategic development of research organization University of Finance and Administration, Prague. The authors also appreciate the cooperation of Petr Mikolajek in collecting and processing data.

## References

1. Adamec, J.: Factors predicting financial distress (in Czech). In: Proceedings of international scientific doctoral conference INPROFORUM Junior 2010, 14-28. Jihočeská univerzita, České Budějovice (2010).
2. Altman, E. I.: Bankruptcy, Credit Risk, and High Yield Junk Bonds. Blackwell Publisher, Inc., Massachusetts (2002).
3. Altman, E. I., Hotchkiss, E.: Corporate Financial Distress and Bankruptcy: Predict and Avoid Bankruptcy, Analyze and Invest in Distressed Debt. 3rd edition. John Wiley & Sons, New Jersey (2005).
4. Chen, H. J., Huang, S. Y., Lin, C. S.: Alternative diagnosis of corporate bankruptcy: A neuro fuzzy approach. *Expert Systems with Applications*, 36(4), 7710-7720 (2009), DOI: 10.1016/j.eswa.2008.09.023.
5. Čámská, D., Hájek, J.: Companies related to the glass making industry and their financial health. In: Kislingerová E., Špička J. (eds.), *Transakční náklady českých ekonomických subjektů v insolvenčním řízení, možnosti jejich snižování a zlepšení statistiky insolvenčních řízení*. 11-12, Oeconomica, Praha (2012),
6. Darmovzal, J.: The use of neural networks in the design of credit/bankruptcy models (in Czech). Dissertation. Masaryk University, Brno (2015).
7. Divišová, P.: The Use of Methods for Evaluation of Financial Health of Companies Operating in Chemical Industry. In: Proceedings of the 5th International Conference on AEBD '13, Chania, 1. 240-245, WSEAS, Crete Island, Greece (2013),
8. Dluhošová, D., Zmeškal, Z.: Z-Metrics methodology and Altman rating models Evolution. In: Proceedings of international conference Financial management of firms and financial institutions, pp. 88-98. VŠB-TU, Ostrava (2011). Retrieved from <http://www.ekf.vsb.cz/frpf/cs/archiv/rocnik-2011/>, last assessed 2016/02/12.
9. Grice, J. S., Dugan, M. T.: Re-estimations of the Zmijevski and Ohlson Bankruptcy Prediction models. *Advances in Accounting*, 20, 77-93 (2003). DOI: 10.1016/S0882-6110(03)20004-3.



10. Karas, M., Režňáková, M.: The Impact of Methodology on the Effectiveness of Bankruptcy Modelling. In: Proceedings of the International Conference on Economics and Business Administration (EBA 2013), 565-574, WSEAS, Greece (2013).
11. Karas, M., Režňáková, M.: A Parametric or Nonparametric Approach for Creating a new Bankruptcy Prediction Model: The Evidence from the Czech Republic. *International journal of Mathematical Models and Method in Applied Sciences.* , 8(1), 214-223 (2014).
12. Klieštík, T., Birtus, M.: The application of neural networks in corporate governance, *Acta oeconomica cassoviensia*, 5(1), 32-40 (2012).
13. Klečka, J., Scholleová, H.: Bankruptcy models enuntiation for Czech glass making firms, *Economics and Management*, 4, 954-959 (2016).
14. Kubíčková, D.: Bankruptcy Prediction and Qualitative Parametres: The Ohlson's Model and its Variants In: proceedings of the 7<sup>th</sup> international scientific conference Finance and Performance of Firms in Science, Education and Practice, T. Bata University, Zlín (2015). Available at: <http://ufu.utb.cz/konference/sbornik2015.pdf>, last assessed 2018/09/24.
15. Maślanka, T.: Verification of the effectiveness of prediction models of bankruptcy of Polish enterprises (in Polish), *Zeszyty Naukowe* (No 12), Polskie Towarzystwo Ekonomiczne, Kraków, 199-206 (2012)
16. Merkevicius, E., Garšva, G., Girdzijauskas, S.: A Hybrid SOM-Altman Model for Bankruptcy Prediction. In: Proceedings of The 6th International Conference on Computational Science (ICCS), 364-371. Springer, United Kingdom (2006)]. Available at: <https://books.google.cz/books?id=2XBwejepMaMC&pg=PA364>, last assessed 2018/04/10
17. Moghadam, A. G., Zadeh, F. N., Fard, M. M. G.: Review of the prediction power of Altman and Ohlson Models in predicting bankruptcy of Listed Companies in Tehran Stock Exchange. *Iran. Houston Business Journal*. Vol. 19, 1-14 (2003).
18. Neumaier, I., Neumaierova, I.: Index IN05. In: Proceedings of the international conference Evropské finanční systémy, 143-149. Masaryk University, Brno (2005).
19. Prusak, B.: How to recognize a potential bankrupt? Assessment of enterprise bankruptcy risk based on a multidimensional discriminant analysis (in Polish). In: Proceedings Bławat F. (ed.), *Prace naukowe Katedry Ekonomii i Zarządzania Przedsiębiorstwem Politechniki Gdańskiej*, 183-210, Politechnika Gdańsk (2004). Available at: <http://www.zie.pg.gda.pl/~pb/jrpb.pdf>, last assessed 2018/09/08.
20. Wang, Y., Campbell, M.: Financial Ratios and the Prediction of Bankruptcy: The Ohlson model Applied to Chinese Publicly Traded Companies. *Journal of Organizational Leadership and Business*. Vol. 17(1) 2, 75-88 (2010).
21. Wu, Y., Gaunt, C., Gray, S.: A comparison of alternative bankruptcy prediction models. *Journal of Contemporary Accounting & Economics*. 6, 34-45 (2010).
22. Zdeněk, R.: Using discriminatory analysis and logistic regression in financial analysis (in Czech). In: proceedings INPROFORUM 2013, 381-387, Jihočeská universita, České Budějovice (2013).
23. Zhang, L., Altmant, E. I., Yen J.: Corporate financial distress diagnosis model and application in credit rating for listing firms in China. *Front Comput.Sci*. 4 (2), 220-236 (2010).

## Regional Differences in Economic and Social Development in Poland - Evaluation and Recommendations

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**Abstract.** This paper discusses variations in the level of development of Polish regions. These variations have resulted from prolonged socio-economic transformation processes over time. They are rather durable in nature and tend to deepen. In stimulating the development and bridging gaps between regions a significant role is played by policies implemented in particular areas, policies that should be considered as one of the most important determinants of regional development. This paper also gives some recommendations for the regional policy. In the context of eliminating adverse spatial differences one should favour the conduct of policies targeted more at the support of underdeveloped regions. The challenge facing Poland's regional policy is to design a model of development policy in which the participation of national and local governments in the area of decision-making and financial support is greater than ever before. Stimulating regional development based on the metropolis and processes of diffusion of growth factors should be backed by simultaneous decisive action involving bottom-up development of their regional environment.

**Keywords:** Poland's Regional Policy, Poland's Regions', Regional Developmental Differences in Poland.

### 1 Introduction

There are two main aspects of socio-economic development processes. One involves the creation and expansion of social income, and the other – its division. Indeed, development varies in time and space. Variation of development in time means that each of its stages is characterised by variable dynamics. Variation in the development process in space is associated with unequal distribution of social income among different territorial units. This situation, in turn, generates spatial differences in development levels, which becomes evident at different scales – global, national, regional and local.

Classical theories of polarization, on the basis of which many new ideas have developed today, assume that development is a process that does not proceed evenly in space, but its factors have a tendency towards focusing on selected growth poles [11]. The basis of accumulation of differences between individual countries and regions is

the accumulation of political, economic and cultural events in the most attractive locations for production factors. Market mechanisms are not conducive to optimal allocation of production factors. One of the manifestations of market failure are the barriers which hinder entering it. These barriers also concern access to new technologies, which are a prerequisite for development [8]. Technological progress is endogenous, and for this reason access to the new technologies of given countries is varied. Consolidation of the economic advantages of the highly developed countries promotes openness of economies and international trade. The benefits of international exchange are not symmetrical for all participating countries. The growing process of globalization and economic integration, as well as greater openness of economies, promotes the removal of barriers hindering competition and increases disparities in development levels and the living standards of people in given countries and regions. This results in the polarization of economic activity in the economically strongest regions and at the same time marginalizes the weaker regions.

In view of the mechanisms leading to polarisation of development, attempts to reduce spatial differences and the stimulate less developed regions constitute some of the most important objectives of the Polish and European regional policy. Activities arising in connection with the policy must be stronger than the market forces that resist them. Otherwise, the ongoing processes of polarisation will lead to the marginalisation of less developed regions which tend to be located far from Europe's central growth areas, especially from places of high concentration of science and technology.

Spatial variation in the socio-economic development of regions generates many negative consequences, for which reason the EU, as part of its cohesion policy, is taking extensive action in order to reduce such differences.

In this article the author analyses regional differences in Poland. Also included are some recommendations for regional policy implementation in the future.

## **2 Spatial Variation in Poland**

Poland is divided into 16 NTS type 2 regions. This territorial division was adopted in an administrative and territorial reform of the country and has been in force since January 1999. The reform was implemented with a view to decentralisation of power and empowerment of Poland's regions, entailing their creation and empowerment as agents of government and public administration. The changes were spurred by the conditions and principles underlying the development policy in EU countries.

The subsequent analysis of regional differences in Poland focuses on the period between the delimitation of the current provincial boundaries, i.e. the 1999 and 2016.

GDP per head of population is a synthetic indicator of the socio-economic development of the regions. On the basis of this index the author computed the coefficient of dispersion of regional GDP per head of population in Poland, which is a measure of sigma ( $\sigma$ ) type convergence. It occurs when absolute values of development level measures become equal. The second type of convergence – type ( $\beta$ ) convergence implies a higher development rate of less developed units in comparison with their more

developed counterparts. However, the existence of ( $\beta$ ) convergence does not always entail sigma ( $\sigma$ ) type convergence.

The dispersion ratio is calculated as the sum of values of absolute differences between the values of per capita GDP in each province and the value of the country's GDP per head of population, weighted by the share of each province's population in the total population of the country. This ratio is expressed as a percentage of the country's GDP per head of population. The greater the distance between the regional and national GDP (calculated as a weighted average), the higher the dispersion rate.

As regards Poland's regions this indicator increased over the period 1999-2011 from 17.5% to 22.0 % (see Table 1). This indicates that the period in question witnessed sigma ( $\sigma$ ) type divergence, which can signal an increase in differentiation between Poland's provinces. In 2012 it decreased to level 20.8% and remained on the similar level until 2015.

**Table 1.** Indicator of dispersion of regional GDP per head of population in Poland [13].

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
Indicator value	17.5	17.5	18.3	17.9	18.3	18.7	19.3	19.7	19.9
Year	2008	2009	2010	2011	2012	2013	2014	2015	
Indicator value	19.6	20.7	21.5	22.0	20.8	20.7	20.8	20.8	

A more detailed analysis of regional differences in Poland was conducted on the basis of selected indicators that characterise different aspects of socio-economic development.

Out of all the analysed aspects, in 1999 the largest differences between the regions were ascertained in terms of research and development outlays per head of population, as evidenced by the high value of the coefficient of variation (99.2%) calculated on the basis of this characteristic in the different regions (see Table 2). The ratio of the highest value to the lowest one for this characteristic was 22: 1. The largest research and development outlays were revealed in Mazowieckie province, followed by Małopolskie, Łódzkie and Dolnośląskie provinces. The least favourable in this respect was the situation in Lubuskie, Opolskie and Podlaskie provinces.

Large regional differences were also observed in investment outlays, although here the differences were not as pronounced as in the above case. The coefficient of variation stood at 42.7%, and the relationship between the values of the characteristic in the best province (Mazowieckie) and the weakest (Warmińsko-Mazurskie) was 3.9: 1. Mazowieckie province excelled on this count again and was followed by Dolnośląskie, Wielkopolskie and Śląskie. The smallest investment was recorded in Warmińsko-Mazurskie, Lubelskie and Podlaskie provinces.

**Table 2.** Selected indicators of socio-economic development of Poland's provinces in 1999 [13].

Region	1	2	3	4	5	6	7	8
Dolnośląskie	17928	16.0	33520	3605	9700	581	95	91.5
Kujawsko-pomorskie	15154	16.9	28397	2239	10818	513	57	75.3
Lubelskie	12260	12.9	29934	1780	5475	491	75	71.5
Lubuskie	15574	17.5	30538	2913	9474	549	18	55.8
Łódzkie	15630	14.3	30680	2510	9987	575	100	88.8
Małopolskie	14981	10.2	28800	2646	9388	560	134	144.3
Mazowieckie	26608	9.5	52237	6829	16830	680	398	79.5
Opolskie	14398	13.2	38707	2645	10144	507	34	89.1
Podkarpackie	12397	14.5	25964	1998	7575	477	67	81.4
Podlaskie	12742	12.5	30767	1904	6103	479	35	51.4
Pomorskie	17427	13.8	33660	3159	11047	568	90	63.3
Śląskie	18406	10.4	37321	3323	15391	597	81	160.9
Świętokrzyskie	13328	15.1	30092	2204	7290	468	73	96.3
Warmińsko-mazurskie	13432	22.4	29361	1743	7445	466	36	50.3
Wielkopolskie	18058	10.5	33837	3353	13708	559	86	78.5
Zachodniopomorskie	17220	18.1	36157	2594	9164	591	40	58.1
Average	15971	14.2	33123	2840	9971	541	89	83.5
Coefficient of variability	22.0	24.1	18.6	42.7	31.5	10.9	99.2	36.8

1- Gross domestic product per capita in PLN, 2- Registered unemployment rate in %, 3- Gross value of fixed assets per capita in PLN, 4- Investment outlays per capita in PLN, 5- Sold production of industry per capita in PLN, 6- Average household's disposable income per capita in PLN, 7- Gross domestic expenditures on research and development per capita in PLN, 8- Hard surface public roads per 100 km<sup>2</sup> in km.

The density of hard surface public roads was another analysed characteristic on whose account regions differed significantly. In this respect, the centrally located region of Mazowieckie ranked only number eight. This reflects its poor spatial infrastructure in areas other than the capital city of Warsaw. Śląskie province excelled in this respect, followed by Małopolskie and Świętokrzyskie in the third place. The lowest road density was revealed in Warmińsko-Mazurskie, Podlaskie and Lubuskie.

The smallest spread between regions occurred in terms of the average household's disposable income. The coefficient of variability for this characteristic was 10.9%, with income in the highest-ranking region of Mazowieckie being one and a half times higher than that of the weakest Warmińsko-Mazurskie.

Analysis of selected indicators confirms a clear superiority of Mazowieckie province over the other provinces. In 1999 it ranked the best in seven out of eight characteristics and stood a long way ahead of the remaining provinces. Across the country Śląskie, Wielkopolskie and Dolnośląskie followed by Pomorskie and Małopolskie stand out positively. The weakest group is constituted of the provinces of eastern Poland. They

faired particularly bad in terms of per capita GDP and investment outlays, sold production of industry and the available income of households.

The development processes between 1999 and 2016 only served to deepen the differences between Polish regions. For a majority of the studied aspects of development (five out of eight) the differences in 2016 were even higher than in 1999. (see Table 3).

**Table 3.** Selected indicators of socio-economic development of Poland's provinces in 2016 [13].

Region	1 <sup>a)</sup>	2	3	4	5	6	7	8
Dolnośląskie	52203	7.2	100975	5255	40177	1586	372	97.8
Kujawsko-pomorskie	38190	12.0	77765	2551	26014	1309	139	98.4
Lubelskie	32074	10.3	74009	1795	17180	1299	293	87.4
Lubuskie	39052	8.6	100919	3555	32317	1499	82	62.3
Łódzkie	43772	8.5	91646	3706	30434	1458	281	111.9
Małopolskie	42160	6.6	82090	3160	26547	1423	947	164.3
Mazowieckie	74682	7.0	143035	6354	46107	1781	1284	104.3
Opolskie	37816	9.0	85077	6546	25460	1390	139	89.4
Podkarpackie	33176	11.5	76443	2601	20531	1134	359	93.7
Podlaskie	33272	10.3	79597	2118	19484	1420	150	65.1
Pomorskie	44955	7.1	90359	3704	37525	1560	535	73.4
Śląskie	48670	6.6	93414	4375	47248	1513	264	176.5
Świętokrzyskie	33841	10.8	72750	1624	19431	1306	107	121.9
Warmińsko-mazurskie	33179	14.2	74783	2073	21795	1372	115	55.4
Wielkopolskie	50790	4.9	97675	4286	45735	1400	311	97.1
Zachodniopomorskie	39569	10.9	92465	2412	23292	1483	110	60.9
Average	42338	9.0	89563	3507	29955	1433	343	97.0
Coefficient of variability	25.5	27.2	19.2	43.8	34.6	10.2	96.8	35.2

a) figures for 2015

1- Gross domestic product per capita in PLN, 2- Registered unemployment rate in %, 3- Gross value of fixed assets per capita in PLN, 4- Investment outlays per capita in PLN, 5- Sold production of industry per capita in PLN, 6- Average household's disposable income per capita in PLN, 7- Gross domestic expenditures on research and development per capita in PLN, 8- Hard surface public roads per 100 km<sup>2</sup> in km.

The greatest differences continued to be seen in gross domestic expenditures on research and development. In 2016 the variation coefficient for this characteristic stood at 96.8% and the value of per capita expenditure in the best region – Mazowieckie was nearly 16 times higher than that in the weakest – Lubuskie. The difference in this case narrowed on 1999 however, which is a welcome development.

The investment outlays still continued to significantly differentiate the domestic space. The variation coefficient stood at 43.8% and the ratio of the highest to the lowest value was 4.0 : 1.

The disparity in terms of the sold production of industry. The variation coefficient stood at 34.6% and the ratio of the highest to the lowest value was 2.8 : 1.

However, a sizeable narrowing of the gap between density of public roads should be viewed as a positive change. In this case, the coefficient of variation decreased from 36.8% to 35.2%.

The 17 years under analysis, in principle, did not witness a change in the situation of individual provinces in terms of socio-economic development.

Mazowieckie continued to stand out. Other relatively highly developed regions, as before, include the provinces of Śląskie, Dolnośląskie, Wielkopolskie and Pomorskie. There was no change in the situation of the least developed regions of Eastern Poland. In terms of most of the development aspects under analysis they occupied the lowest places in the national ranking and fared particularly badly in terms of per capita GDP and sold production of industry.

The analysis indicates that the national spatial diversity is quite pervasive in nature and tends to deepen. Similar conclusions can be drawn from studies carried out by other authors [1, 2, 4, 6, 10].

The increase in disparity was noted in most of the characteristics studied. This means that the less developed regions still have a lot of catching-up to do and despite increased capital expenditure are not able to quickly make up for accumulated gaps separating them from more developed ones. This confirms the rule that lagging economies usually achieve higher growth rates, but because they start from a lower level, they are not able to quickly bridge the gap between them and highly developed economies.

### **3 Recommendations for Regional Policy**

In stimulating development and bridging the spatial gap great importance is attributed to the way in which policies relating to certain areas are implemented as these policies should be considered to be one of the most important factors of regional development.

In the cohesion policy programming period 2014-2020, Poland remains to be one of its major beneficiaries. The funds granted to Poland amount to EUR 82.5bn. It offers great development opportunities for Polish regions, accelerating the process of advancement.

Although, according to the analysis, the differences in levels of development in the Polish and European space increased, it cannot be inferred that cohesion policy is ineffective. The possibility of using European cohesion policy instruments provides less-developed regions with a chance to accelerate the process of socio-economic development. It would also be worth considering what the situation would look like if cohesion policy was not in place at all. Then probably the development gap would increase even more. One cannot therefore question the rationale for the implementation of cohesion policy and its continuation in the next programming periods, although certainly one could hope for better results. It should also be noted that the effects of

cohesion policy are long-term, and the development activities initiated by the policy will generate long-term results.

In the context of the implementation of European cohesion policy in Poland and the related availability of EU aid, attention should also be paid to the unfavourable regularity whereby regional policy in Poland was dominated by the European cohesion policy [5]. Objectives and policies relating to the conduct of regional development policy, as defined in the Polish legislative and programme documents created at the national and regional level clearly refer to and reflect the rules and guidelines contained in the documents drafted at the EU level. This is, of course, dictated by the possibility of tapping into the financial aid package offered by the European Union. And the funds under the European Regional Development Fund account for more than 80 % of the total amount allocated to the implementation of the regional operational programmes.

Meanwhile, cohesion policy should constitute only one of many points of reference for regional policy, and national and local governments should have much more leeway in making their financial decisions. The European Commission does not impose any restrictions ruling out parallel pursuit of provinces' own specific objectives. The fact that in the case of Polish regions that does not happen is associated with the regions' and countries' economic and financial weakness manifesting itself in lack of funds for additional activities and investments which are considered important and necessary in different territorial units.

In the context of eliminating adverse spatial development differences one should declare support for the need to conduct more targeted policies supporting underdeveloped regions. At the same time, one should be aware that it is not possible to achieve full convergence within the meaning of equalising individual province's level of development. The objectives of a policy targeting underdeveloped regions should be to harness their potential so as to allow them to initiate development stimuli on the basis of their endogenous potential coupled with a realistic inclusion of the emerging possibilities and existing constraints.

Therefore, one should strongly recommend efforts to develop a model of regional policy in which the participation of local and regional authorities in the sphere of decision-making and financing is greater. With this in mind it would be advisable to further decentralise government and financing, transferring more competencies than before as well as more financial resources. The case for increasing decentralisation was made in writing in the National Regional Development Strategy [9]. However, its provisions do not translate in practical measures because there are no precise indications as to how to achieve greater decentralisation. There is no doubt that the income level of local government units is still too low compared with their development requirement, which is a factor curtailing their ability to take a number of key actions and investments.

Also, in the context of the public sector's reduced financial potential, private companies should be more actively engaged in supporting the innovativeness of particular regions.

One should also refer to other provisions of the National Regional Development Strategy promoting the use of the polarisation and diffusion model of regional development. This means focusing on supporting the most competitive entities, which



in turn are expected to diffuse development processes to other areas. This amounts to strengthening the metropolitan functions of major urban centres (mainly provincial capitals) as the most competitive ones in the regional space and creating conditions for the diffusion of development processes in other areas.

It does not seem appropriate to ground the development of provinces solely on their leading hubs. As regional development theories and economic practice demonstrate the development of large cities and concentration of potential in central places is an objective market phenomenon. Supporting the growth poles in their capacity as the most competitive drivers of development would only intensify natural market processes resulting in polarisation of space. The more so because, according to Heffner [3], the effect of metropolisation in Poland is small as it does not exceed 20-30 km, with Warsaw being a notable exception reaching out some 40-50 km. However, more outlying regional environment undergoes the leaching of resources, resulting in a rise in unemployment, decline in the number of business entities and a negative migration balance.

Stimulating a province's development on the back of the metropolis and processes of diffusion of growth factors should be supported by firm simultaneous measures promoting bottom-up development of province's regional environment through the development of networks of small cities and towns that are sub-regional and local development hubs and additionally through activation of rural areas. One should agree with Prusek [12], who emphasises that the lack of adequate support for less developed areas, coupled with the promotion of the metropolis, will increase the polarisation processes. However, the endogenous potentials of the most developed cities are so strong that they will continue to grow, even without state support.

This recommended bottom-up stimulation of regional development by activating towns and rural areas must be associated with efforts to increase the competitiveness of these areas so as to make them more attractive to their populations and potential investors. Kudłacz [7] points out that it is particularly important to retain development factors locally, including human capital. For the environment of the most developed hubs to respond to development stimuli, the former must be reveal adequately mature development. This involves real processes, which manifest themselves through the existence of adequate institutional basis for co-operation as well as regulatory processes, depending as they are mainly on the attitudes of local authorities.

The basic feature underlying the attractiveness of towns is the availability of companies offering quality jobs and high wages. But beyond that, the smaller localities must have public services, including education, health and culture whose quality is equal to that in major cities. Highlighting advantages of smaller localities must go hand in hand with the creation of new projects, including for the public.

The implementation of the regional policy is based on the well-grounded assumption of its territorial dimension. Particular regions have their strengths and weaknesses and face unique challenges. Therefore, intervention policies should be constantly modified in response to local conditions. This approach provides opportunities for an effective use of particular regions' endogenous potential.

## 4 Conclusions

Spatial differentiation can be considered to be an objectively occurring phenomenon in all countries and regions of the world.

Regional differences in Poland are rather durable and tend to deepen.

In the context of eliminating adverse spatial differences one should favour the conduct of policies targeted more at the support of underdeveloped regions.

In recent years, regional policy in Poland was dominated by the European cohesion policy. These manifests itself both in the process of formulating the goals and principles of the policy towards the region and in its financing.

The challenge facing Poland's regional policy is to design a model of development policy in which the participation of national and local governments in the area of decision-making and financial support is greater than ever before. This implies a need for greater decentralisation involving granting local governments more leeway and funds than previously.

Stimulating regional development based on the metropolis and processes of diffusion of growth factors should be backed by simultaneous decisive action involving bottom-up development of their regional environment.

Endogenous stimulation of a region's development by activating smaller cities, towns and rural areas must be coupled with efforts to increase these areas' competitive edge so as to make them more attractive to their populations and potential investors.

Complete elimination of the differences between underdeveloped regions and the more developed ones is therefore not a measure of the success of policies aimed at the former. Such success manifests itself in the stimulation of economic development in a way that will allow them to initiate growth stimuli.

## References

1. Dorocki, S.: Przestrzenne zróżnicowanie rozwoju społeczeństwa informacyjnego w Polsce. *Rozprawy Naukowe Instytutu Geografii i Rozwoju Regionalnego Uniwersytetu Wrocławskiego*, 27, 131-145 (2012).
2. Gorzelak, G.: Fakty i mity rozwoju regionalnego. *Studia Regionalne i Lokalne*, 2(36), 5-27 (2009).
3. Heffner, K.: Regiony międzymetropolitalne a efekty polityki spójności w Polsce. In: Klamut, M., Szostak, E. (eds.) *Jaka polityka spójności po 2013 r.*, pp. 163-184, Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław (2010).
4. Korenik, S.: Region ekonomiczny w nowych realiach społeczno – gospodarczych. Wydawnictwo CedeWu, Warszawa (2011).
5. Kudelko, J.: Rola europejskiej polityki spójności w krajowej i regionalnej polityce rozwoju. In: Klamut, M., Szostak, E. (eds.) *Jaka polityka spójności po 2013 r.*, pp. 223-232, Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław (2010).
6. Kudelko, J.: Uwarunkowania i kierunki rozwoju województw Polski Wschodniej jako regionów słabo rozwiniętych. *Studia KPZK PAN*, Warszawa (2013).
7. Kudłacz, T.: Polityka rozwoju regionalnego Polski drugiej dekady XXI w. Spostrzeżenia i oceny dotyczące rozwiązań przyjętych w KSRR. In: Kudłacz, T. (ed.) *Rozwój regionalny w Polsce w świetle wyzwań XXI w.*, pp. 20-31, *Studia KPZK PAN*, Warszawa (2010).

8. Lucas, R.: On the mechanics of economic development. *Journal of Monetary Economics*, 22(1), 3-42 (1988).
9. Ministerstwo Rozwoju Regionalnego: Krajowa Strategia Rozwoju Regionalnego 2010-2020. Regiony, Miasta, Obszary wiejskie, Warszawa.
10. Pawlik, A.: Potencjał innowacyjny podstawą rozwoju regionalnego. In: Harańczyk, A. (ed.) *Perspektywy rozwoju regionalnego Polskie w okresie programowania po 2013 r.*, pp. 67-78, Studia PAN KPZK, Warszawa (2011).
11. Perroux, F.: Economic space, theory and applications. *Quarterly Journal of Economics*, 64 (1), 89-104 (1950).
12. Prusek, A.: Endogeniczny rozwój regionów opóźnionych w rozwoju w warunkach europejskiej polityki spójności i strategii lizbońskiej. In: Prusek, A. (ed.) *Problemy i efekty polityki spójności w polskich regionach*, pp. 58-69, Wydawnictwo Wyższej Szkoły Gospodarki i Zarządzania w Krakowie, Kraków (2009).
13. *Roczniki Statystyczne Województw, years 1999-2017*, GUS, Warszawa.

## Trends and Status of Agribusiness in Animal Husbandry of the Russian Federation

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**Abstract.** The article notes that agriculture in any country performs a socially significant task, providing the population with essential foodstuffs. Very often, agribusiness because of the large difference between the prices of industrial and agricultural products is low profitable or unprofitable. The identification of current trends and analysis of the current state of agribusiness in the livestock industry of the Russian Federation is the goal of this study. For the period from 2000 to 2017, the increase in the share of meat production in large-scale formations in them occurred in the country. In the structure of the concentration of livestock animals, there was an overflow of the number of livestock of domestic animals from large-scale to small-scale forms of management: especially cattle, cows, horses from agricultural organizations to peasant (farmer) farms. At present, the polarization of agricultural agri-formations is growing: on the one hand, the number of agricultural holdings is growing, on the other hand, the number of peasant (farmer) farms is increasing. There is a general reduction in the number of large livestock and an increase in the number of livestock of small domestic animals. Currently, strategic management decisions are needed to increase the level of food self-sufficiency of the population with meat, milk and meat and dairy products. It is very important to preserve the rural way of life, rural social infrastructure facilities, as well as rural jobs for 26% of rural residents of the country.

**Keywords:** Livestock, Forms of Management, Livestock, Livestock Structure, Production Structure.

### 1 Introduction

Agriculture has always occupied and occupies a special place in the economy of any country and is part of national security. Foreign and domestic experience shows that without active government intervention, its control over production and the level of security, timely measures of state support for agricultural producers, and assistance to them in the development of innovations, the industry will not be able to withstand price-to-sector imbalances. In Russia, with its variety of climatic and climatic conditions,

temperature diversity, one of the main food products needed to maintain normal human activity is meat and meat products. This explains not only the choice of the research topic, but also its relevance.

The study of foreign experience clearly shows that on the one hand, in most countries of the world, urbanization contributes to a decline in the number of people who may have large domestic animals in their own farms or work in the public agricultural firms. On the other hand, the increase in gross domestic product and the growth of individual incomes, for example, contribute to higher demand for meat and meat products. This problem is successfully solved by the development of industrial livestock in some countries. However, this entails environmental problems, for the solution of which is devoted the works of scientists. Consider them in more detail.

According to Delgado C. [6], "cities will grow in the next few decades, especially in Africa and Asia," "urbanization has a significant impact on food consumption patterns in general and on demand for animal products in particular".

In the work of Philip K. Thornton [17] notes that "the demand for livestock products in the near future will only increase". According to Dijkman [7], "the development of the livestock industry is the only way to reduce poverty and over the past 20 years, few countries have effectively taken advantage of this opportunity".

In the work of Chinese scientists, it is said that "industrial production of beef is an essential part of livestock and meat production in China. China is the third largest beef producer in the world. Despite this, China's self-sufficiency in meat is not complete. According to Derrell S. Peel [5], Oklahoma State University Extension The main suppliers of beef to China in 2016 were Brazil (29% of all Chinese imports), Uruguay (27%), Australia (19%), New Zealand (12%), Argentina (9%), other countries - 4%. In 2017, the import of beef to China was planned at the level of 950 thousand tons, which is 17% more than in 2016".

The growing demand for livestock products is growing with the growth of gross domestic product. In their work, Xiang, Zi Li., Chang, Guo Yan, Lin, Sen Zan [18] note, that "the Chinese beef industry faces technical problems, including the transformation of traditional production management, feeding systems, management, genetic improvement of cattle breeds".

In the work of Herrero M. et al [8], devoted to the study of intelligent investment in sustainable food production: a revision of mixed livestock systems "the author emphasizes that" in small-sized farms around the world, livestock is grown mainly on grass, biomass and non-food biomass from corn, millet, rice, sorghum, and manure, in turn, is directed at increasing the yields of future crops. " The author is absolutely right when he rightly notes that "animals act as insurance against hard times and are a regular source of income for farmers from the sale of milk, eggs and other products. With population growth and climate change, small farmers should be the first targets for policies aimed at enhancing production through well-managed resources (fertilizers, water, feed, and minimizing the environmental impact of waste".

In the work of scientists King D., Peckham C., Waage J.K., Brownlie J., Woolhouse M.E.J. [12] considered «factors that could influence the growth of infectious diseases that could cause harm to people, plants and animals», and "technological and political decisions" are needed to manage the situation».

Worldwide, it is believed that animal husbandry causes serious environmental damage due to methane emissions, while animal husbandry accounts for 18% of the global anthropogenic emissions of this gas [11]. Some authors suggest "improving feeding methods, using specific agents or food additives"[16]. Beauchemin and McGinn [4] also write about this in their work, emphasizing that "the net benefit depends on a decrease in the number of animals, or earlier slaughter of animals (at a younger age)", as well as "through the use of more concentrates".

Some authors suggest adding oil to the animals' diet to reduce methane production (for example, Machmüller A et al. [15]). Other authors suggest improving pasture quality for this purpose, especially in less developed regions (Alcock & Hegarty [2]).

For the development of agriculture in Russia was devoted to the works of numerous Russian scientists, including our earlier works (Kuznetsova A.R. et al [3, 10, 13, 14]). Thus, scientists in different parts of the world solve the problems of livestock development, seeking the most rational technologies. The Russian agriculture has developed its own traditions and tendencies of doing business in animal husbandry. As everywhere, there are some positive aspects and problems.

## 2 Trends and Status in Animal Husbandry in the Russian Federation

The methodological basis of the study was general scientific research methods, interdisciplinary system-functional, statistical, computational-constructive, economic-mathematical, graphical and other scientific approaches. We used tabular and graphical methods of statistical analysis of the main indicators for a comprehensive study of the problem.

The information base of the study was made up of official data from the Federal State Statistics Service of the Russian Federation, information resources of the global Internet and the results of its own research.

The aim of our study is to study the dynamics of changes in the structure of livestock production by the forms of management in the Russian Federation.

According to the Federal State Statistics Service of the Russian Federation, in the period from 2000 to 2017 in the Russian Federation, the number of livestock of agricultural animals underwent certain changes (Table 1).

**Table 1.** Livestock of farm animals in the Russian Federation in farms of all categories from 2000 to 2017 (thousand heads) [1, 9].

Indicators	2000 y.	2010 y.	2015 y.	2016 y.	2017 y.	2017 y. in % to 2000 y.
Cattle	27519.8	19967.9	18992.0	18752.5	18681.0	67.9
cows	12742.6	8843.5	8408.1	8263.7	8226.0	64.6
Pigs	15824.4	17217.9	21506.8	22027.7	23185.2	146.5
Sheep and goats	14961.9	21819.9	24881.1	24843.8	24489.8	163.7
sheeps	12730.5	19761.3	22713.1	22744.4	22401.4	176.0
goats	2231.4	2058.5	2168.1	2099.4	2088.4	93.6

Indicators	2000 y.	2010 y.	2015 y.	2016 y.	2017 y.	2017 y. in % to 2000 y.
Horses	1622.2	1340.6	1374.2	1381.3	1403.8	86.5
Bird	340665	449296	547195	553007	561281	164.8
Reindeer	1197.0	1571.0	1606.1	1650.8	1687.5	141.0
Rabbits	1276.7	2653.1	3721.2	3818.4	3909.8	306.2

From the data presented in table 1 it follows that the number of cattle in the Russian Federation from 2000 to 2017 decreased by 32.1%, cows - by 35.4%, goats - by 6.4%, horses - by 13.5%.

The number of pigs in the farms of all categories of pigs increased by 46.5%, sheep and goats - by 63.7% (including sheep - by 76%), birds - by 64.8%, northern deer - by 41%, rabbits - 3.1 times.

Consider the structure of the livestock of agricultural animals in the Russian Federation according to the forms of management in table 2.

**Table 2.** The structure of the livestock of farm animals by forms of management in the Russian Federation for the period from 2000 to 2017 [1, 9].

Indicators	2000 y.	2010 y.	2015 y.	2016 y.	2017 y.	2017 y. in % to 2000 y.
Agricultural organizations						
Cattle	27519.8	19967.9	18992.0	18752.5	18681.0	67.9
cows	12742.6	8843.5	8408.1	8263.7	8226.0	64.6
Pigs	15824.4	17217.9	21506.8	22027.7	23185.2	146.5
Sheep and goats	14961.9	21819.9	24881.1	24843.8	24489.8	163.7
sheeps	12730.5	19761.3	22713.1	22744.4	22401.4	176.0
goats	2231.4	2058.5	2168.1	2099.4	2088.4	93.6
Horses	1622.2	1340.6	1374.2	1381.3	1403.8	86.5
Bird	340665	449296	547195	553007	561281	164.8
Households						
Cattle	38.0	44.5	46.2	43.7	42.7	42.4
cows	47.1	50.7	49.9	46.2	45.0	44.6
Pigs	43.6	42.9	32.6	16.1	14.5	12.6
Sheep and goats	63.5	52.5	51.7	46.6	46.2	46.5
sheeps	58.5	48.8	48.6	43.7	43.4	43.7
goats	92.3	80.7	81.4	76.9	76.8	76.5
Horses	50.2	56.0	54.3	52.6	51.4	51.9
Bird	39.2	31.6	21.5	16.9	16.5	15.7
Peasant farms						
Cattle	2.0	4.3	7.4	11.8	12.7	13.4
cows	2.0	4.3	8.1	13.5	14.4	15.1
Pigs	2.6	4.1	4.6	2.1	2.0	1.8
Sheep and goats	5.9	24.5	28.0	35.9	36.8	37.0

Indicators	2000 y.	2010 y.	2015 y.	2016 y.	2017 y.	2017 y. in % to 2000 y.
sheeps	6.2	26.3	29.9	38.1	38.9	39.0
goats	4.1	10.7	9.7	13.3	13.7	15.1
Horses	4.1	8.8	16.2	24.8	26.7	27.6
Bird	0.6	0.9	1.0	1.8	1.8	1.7

From the data presented in table 2 it follows that in agricultural organizations the proportion of cattle population for the period from 2000 to 2017. decreased from 60% to 44.2% (by 15.8 pp), cows - from 50.9% to 40.3% (by 10.6 pp), sheep - from 35.3% to 17.3% (by 18 pp), horses - from 45.7% to 20.5% (by 25.2 pp). The share of poultry in agricultural organizations increased from 60.2% to 82.6% (by 22.4%), pigs from 53.8% to 85.6% (by 31.8 pp), goats - from 3.6% to 8.4% (by 4.8 pp).

In households of the population of the Russian Federation for the period from 2000 to 2017. the share of cattle livestock increased from 38% to 42.4% (by 4.4 pp), the share of horse livestock increased from 50.2% to 51.9% (by 1.7 pp). The share of livestock of cows in the households for the analyzed period decreased from 47.1% to 44.6% (by 12.5 pp), sheep and goats - from 63.5% to 46.5% (by 17 pp.), including sheep - from 58.5% to 43.7% (increased by 17 percentage points), the proportion of the number of goats decreased from 92.3% to 76.5% (decreased by 15, 8 pp), the proportion of poultry population in household farms decreased from 39.2% to 15.7% (by 23.5 pp). By 2017, the proportion of cattle livestock in peasant (farmer) farms began to be 13.4%, cows - 15%, pigs - 1.8%, sheep and goats - 37%, horses - 27.6%, poultry - 1.7%. Consider the volume of production of main livestock products in the Russian Federation in all categories of farms (table 3).

**Table 3.** Production of basic livestock products in the Russian Federation in farms of all categories, thousand tons [1, 9].

Indicators	2000 y.	2010 y.	2015 y.	2016 y.	2017 y.	2017 y. in % to 2000 y.
Cattle and poultry for slaughter (slaughter weight)	4445.8	7166.8	9565.2	9899.2	10384.4	2.3 times
cattle	1897.9	1727.3	1649.4	1619.0	1613.6	85.0
pigs	1578.2	2330.8	3098.7	3368.2	3529.6	2.2 times
sheep and goats	140.3	184.6	204.5	213.1	221.8	158.1
bird	767.5	2846.8	4535.5	4620.8	4938.6	6.4 times
Milk	32259.0	31847.3	30796.9	30758.5	31183.5	96.7
Eggs, million pieces	34084.7	40599.2	42571.7	43558.9	44890.9	131.7
Wool (in physical weight), tons	40088	53521	55644	56495	56954	142.1
Honey, tons	1197.0	1571.0	1606.1	1650.8	1687.5	141.0



From the data of table 3 it follows that for the period from 2000 to 2017 in farms of all categories, poultry meat production increased 6.4 times; production of livestock and poultry for slaughter increased by 2.3 times, pig meat - by 2.2 times, wool production increased by 42%, eggs - by 31.7%, honey - by 21.1%. During the analyzed period, the production of cattle meat decreased by 15%, milk production decreased by 3.3%.

Consider the structure of production of main livestock products in the Russian Federation by categories of farms (Table 4).

**Table 4.** Structure of production of basic livestock products in the Russian Federation (as a percentage of total production) [1, 9].

Indicators	2000 y.	2010 y.	2015 y.	2016 y.	2017 y.	2017 y. in % to 2000 y.
Agricultural organizations						
Cattle and poultry for slaughter (slaughter weight)	40.2	46.2	60.6	74.5	75.9	77.4
cattle	43.0	36.2	32.7	31.9	33.1	33.7
pigs	27.6	33.2	52.7	78.2	80.7	82.5
sheep and goats	10.8	10.7	8.9	7.9	7.5	7.0
bird	65.4	78.8	88.4	91.5	91.6	92.2
Households						
Cattle and poultry for slaughter (slaughter weight)	58.0	51.4	36.5	22.5	21.1	19.7
cattle	55.2	60.9	62.6	60.2	58.6	57.3
pigs	70.2	64.1	44.4	20.4	18.0	16.3
sheep and goats	85.2	80.6	72.5	70.9	70.2	69.7
bird	34.2	20.6	11.0	7.4	7.3	6.8
Peasant farms						
Cattle and poultry for slaughter (slaughter weight)	1.8	2.4	2.9	2.9	2.9	2.9
cattle	1.8	2.8	4.7	7.9	8.3	8.9
pigs	2.2	2.7	3.0	1.4	1.4	1.2
sheep and goats	4.1	8.7	18.6	21.2	22.3	23.3
bird	0.6	0.9	1.0	1.8	1.8	1.7

From the data of table 4 it follows that for the period from 2000 to 2017. the share of livestock and poultry production for slaughter in agricultural organizations increased from 40.2% to 77.4% (by 37.2 percentage points); pigs - from 27.6% to 82.5% (by 54.9 pp), poultry - from 65.4% to 92.2% (by 26.8 pp). At the same time, the share of cattle meat production in agricultural organizations decreased from 43% to 33.7% (by 9.3 pp), and sheep and goat meat - from 10.8% to 7% (by 3, 8 pp).

For the period from 2000 to 2017 the share of livestock and poultry production for slaughter of the population decreased from 58% to 19.7% (by 38.3 pp), pig meat - from 70.2% to 16.3% (by 53.9 p. p.), poultry meat - from 34.2% to 6.8% (by 27.4 percentage points).

At the same time, there is an increase in the share of cattle meat production in household farms from 55.2% to 57.3% (by 2.1 pp), as well as sheep and goat meat - from 85.2% to 69.7% (by 15.5 percentage points).

In peasant (farmer) farms, the growth of the share of livestock and poultry production for slaughter by 2017 reached 2.9%, cattle — 8.9%, pigs — 1.2%, sheep and goats — 23.3%, birds - 1%.

According to the Ministry of Agriculture of the Russian Federation, the availability of livestock in the Russian Federation (except for pigs and poultry) with feed of its own production in all categories of farms allows organizing uninterrupted feeding of livestock during the winter-stall period, which, in turn, allows high-quality wintering of livestock and complete volume indicators of target indicators of livestock production. Thus, the provision of livestock with rough and succulent feeds for the winter-stall period of 2015-2016 as of January 1, 2016 is 8.5 c. fodder units, which is 3.3% higher than the need. Production and consumption of various types of feed for farm animals in the Russian Federation is 29.5 million tons [3]. At the same time, the need for grain, as the main component of mixed feed, is fully satisfied by domestic raw materials, which completely excludes import dependence.

### 3 Conclusions

- In the Russian Federation for the period from 2000 to 2017. There was an obvious reduction in the number of large livestock and an increase in the number of livestock of small domestic animals. The total number of cattle in the country decreased by about 30%, the number of small animals increased, including: sheep and goats - by 63.7% (including sheep - by 76%), poultry - by 64.8%, pigs - by 46.5%, reindeer - by 41%, rabbits - 3.1 times.
- In the structure of the concentration of livestock animals, there is a flow of livestock numbers of domestic animals from large-scale to small-scale forms of management: especially cattle, cows, horses from agricultural organizations to peasant (farmer) farms.
- In 2017, 44% of cattle, 85.6% of pigs, 82.6% of poultry were concentrated in agricultural organizations. The share of meat products produced in agricultural organizations at the same time for cattle meat was 33.7%, for pig meat - 82.5%, for poultry meat - 92.2%.
- The households of the population in 2017 showed the largest concentration of the number of goats (76.5%), horses (51.9%), cows (44.6%), sheep (43.7%).

At present, the polarization of agricultural agri-formations is growing: on the one hand, the number of agricultural holdings is growing, on the other hand, the number of peasant (farmer) farms is increasing. There is a general reduction in the number of large livestock and an increase in the number of livestock of small domestic animals.

Currently, strategic management decisions are needed to increase the level of food self-sufficiency of the population with meat, milk and meat and dairy products.

## References

1. Agriculture, hunting and forestry. Official site of the Federal State Statistics Service [Electronic resource]. URL: <http://www.gks.ru/>, last accessed: 2018/10/10.
2. Alcock, D., Hegarty, R. S.: Effects of pasture improvement on productivity, gross margin and methane emissions of grazing sheep enterprises. In Second Int. Conf. on Greenhouse Gases and Animal Agriculture, Working Papers (eds C. R. Soliva, J. Takahashi & M. Kreuzer), pp. 127–130. Zurich, Switzerland: ETH. (2005).
3. Avzalov, M.R., Kuznetsova, A.R.: Development of the dairy cattle industry in the Republic of Bashkortostan // International Journal of Applied and Fundamental Research. 2014. №11-5, pp. 774-778. (In Russian)
4. Beauchemin, K., McGinn, S.: Methane emissions from feedlot cattle fed barley or corn diets. J. Anim. Sci. 83, pp. 653–661. (2005).
5. China and global beef markets [Internet] Feedlot; 2016. [Cited 2016 Oct 1]. Available from: <http://feedlotmagazine.com/china-and-global-beef-markets/>, last accessed: 2018/10/28.
6. Delgado, C.: (2005) Rising demand for meat and milk in developing countries: implications for grasslands-based livestock production. In Grassland: a global resource (ed. McGilloway D. A., editor.), pp. 29–39. The Netherlands: Wageningen. (2005).
7. Dijkman, J.: Innovation capacity and the elusive livestock revolution. LINK News Bulletin, October 2009. See: [www.innovationstudies.org](http://www.innovationstudies.org), last accessed: 2018/10/01.
8. Herrero, M. et al.: Smart investments in sustainable food production: revisiting mixed crop-livestock systems. Science 327, 822–825. DOI:10.1126/SCIENCE.1183725. (2010).
9. Information on the state of livestock in 2015. Official website of the Ministry of Agriculture of the Russian Federation [Electronic resource]. Access Mode: [http://mcx.ru/documents/document/v7\\_show/35606.133.htm](http://mcx.ru/documents/document/v7_show/35606.133.htm), last accessed: 2018/10/10.
10. Kabashova, E.V., Kuznetsova, A.R.: Forecasting the average monthly salary of employees using econometric modeling // Russian electronic scientific journal. 2018. №1 (27). C.26-46. DOI: 10.31563/2308-9644-2018-27-1-26-45 (In Russian)
11. Kennedy, P.M, Milligan, L.P.: Effects of cold exposure on digestion, microbial synthesis and nitrogen transformation in sheep. Br. J. Nutr. 39, 105–117. (1978).
12. King, D. A., Peckham, C., Waage, J. K., Brownlie, J., Woolhouse, M. E. J.: Infectious diseases: preparing for the future. Science 313, 1392–1393 (DOI:10.1126/SCIENCE.1129134) [PubMed] (2006).
13. Kuznetsova, A.R., Mambetova, L.R., Valiyeva, G.R., Kadyrov, E.M.: Problems of ensuring food security of the Republic of Bashkortostan // Economics of Agriculture of Russia. 2014, №10, pp.38-45. (In Russian)
14. Kuznetsova, A.R., Zagirova, Z., Omarhanova, Zh.: Problems of agriculture and agriculture. In the collection: Hradec Economic Days Double-blind Meeting of the Economic Days 2018, pp. 523-538.
15. Machmüller, A., Ossowski, D.A., Kreuzer, M.: Comparative evaluation of the effects of coconut oil, oilseeds and crystalline fat on methane release, digestion and energy balance in lambs. Anim. Feed Sci. Technol. 85, pp. 41–60. DOI:10.1016/S0377-8401(00)00126-7. (2000).

16. Murray R.M., Bryant A.M., Leng R.A.: Rate of production of methane in the rumen and the large intestine of sheep. *Br. J. Nutr.* 36, pp. 1–14. DOI:10.1079/BJN19760053. (1976).
17. Thornton, P.K.: Livestock production: recent trends, future prospects. *Sep 27; 365(1554): 2853–2867.* DOI: 10.1098/rstb.2010.0134. (2010).
18. Xiang, Zi Li., Chang, Guo Yan, Lin, Sen Zan: Current situation and future prospects for beef production in China – A review // *Asian-Australas J Anim Sci.* 2018 Jul; 31 (7), pp. 984-991. DOI: 10.5713/ajas.18.0212. (2018).

**Hradec Economic Days**

**Volume 9**

**Issue 1**

Proceedings of the International Scientific Conference

Hradec Economic Days 2019

part I.

February 5–6, 2019.

Editors: Pavel JEDLIČKA, Petra MAREŠOVÁ, Ivan SOUKAL.

Hradec Economic Days are published annually.

Edition size: 130 pcs.

Published: February 5, 2019.

Publisher: University of Hradec Králové.

Publisher's office: Rokitanského 62, Hradec Králové 3, 500 03, Czech Republic.

VAT ID: CZ62690094.

Printer: Optys, spol. s r.o.

Printer's office: U Sušárny 301, Dolní Životice, 747 56, Czech Republic.

VAT ID: CZ42869048.

**ISSN 2464-6059 (Print)**

**ISSN 2464-6067 (Online)**

**ISBN 978-80-7435-735-0**

**DOI: 10.36689/uhk/hed/2019-01-000**