

# Circular Economy from the Perspective of Accounting Data During the Pandemic Period

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**Abstract:** Circular economics refers to a system where production systems are designed to be self-contained regarding resources, allowing for their reuse. The focus of this paper is to analyze accounting data, such as the assets, liabilities, costs revenues, and cash flow for the companies that have implemented elements of the circular economy. The analyzed accounting data were from the period before the pandemic and the period of the pandemic. Statistically significant differences were found in the indicators of long-term financial assets, capital funds, other operating revenues, residual cost of long-term assets and materials, and interest income. The analysis also indicates that companies, unable to fully engage in their business activities, invested more in long-term (financial) assets, which generated profit in the form of interest income, and had to resort to selling part of their long-term (tangible) assets and inventory. The identified statistically significant differences indicate that the pandemic period had a significant impact on the financial and operational activities of companies, which had to adapt to new conditions and strategically invest in long-term assets. These changes in indicators suggest the necessity of adapting and optimizing business strategies in response to emerging challenges.

**Keywords:** analysis of the financial indicators; circular economy; COVID-19; Mann-Whitney U test

**JEL Classification:** A13; M41; O44

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## 1. Introduction

The primary objectives of the circular economy involve reducing resource consumption, which is limited, and instead emphasizing the reintroduction of previously utilized raw materials or waste back into the production process. The circular economy can be defined as an economic model characterized by minimal consumption of primary materials, simultaneous reuse of resources, and high-quality recycling of basic materials. It has gained significant popularity as an approach in today's world. The EU Circular Economy Action Plan 2020 outlines a forthcoming strategy for the European Union (European Union, 2020). "The Secondary Raw Materials Policy of the Czech Republic" is the first document in the Czech Republic that establishes a strategic framework for the efficient utilization of secondary raw materials. The increasing interest in the secondary raw materials industry can be attributed to the continually rising prices of primary resources, their availability within the EU, and, most importantly, the significant material and energy savings that result from their utilization (MPO, 2015).

The circular economy also promotes the shift towards renewable energy sources, fostering economic, environmental, and social capital. It is built upon principles such as waste and pollution minimization, the perpetual cycle of products and materials, and the regeneration of natural systems to ensure value for future generations. Circular economy often adheres to the 3-R approach for resource utilization, which comprises (Kirchherr et al., 2017): 1. Reduce (minimizing the use of raw materials), 2. Reuse (maximizing the reuse of products and components) and 3. Recycle (achieving high-quality reuse of raw materials). The circular economy has a growing trend. This is indicated by the rapid growth of peer-reviewed articles on this topic. More than 100 articles were published on the topic in 2016, compared to only about 30 articles in 2014 (Geissdoerfer et al., 2017). The implementation of circular economy elements may appear straightforward and akin to the simple reuse of resources in today's context. However, there are numerous obstacles in the field of circular economy that hinder companies from enhancing their involvement. These obstacles encompass administrative procedures, regulations, etc. Companies that choose not to participate in the circular economy system often perceive significant barriers in terms of administrative requirements, financing, investments, and costs (Garcés-Ayerbe et al., 2019).

The concept of accounting refers to the systematic process of recording, analyzing, interpreting, and reporting financial transactions and information of an organization. Accounting involves the measurement, classification, and communication of financial data to provide stakeholders with relevant and reliable information for decision-making, financial planning, and performance evaluation. The concept of accounting in relation to the circular economy has already been addressed by several authors. For example, Fischer-Kowalski et al. (2011) deal with the most modern ways of accounting for material flows in the whole economy and at the same time examine the reliability and uncertainty of data in the accounting for material flows. Cleveland et al. (2000), on the other hand, examine energy flow accounting, so-called energy accounting, and discuss suitable indicators for the analysis of ecological systems and the amount of energy put into the production. They found that companies with high environmental performance tend to be profitable. King and Lenox (2008) found evidence of a link between lower environmental pollution and higher financial value. Södersten et al. (2020) introduce a novel measure of material utilization called CAMF - capital-augmented material footprint, which encompasses all materials incorporated within capital assets. Their findings emphasize the importance of comprehensive indicators in evaluating the potential for mitigating the impacts of material and product consumption. As resources become increasingly scarce and the desire for well-being grows among consumers and various societal segments, there is a pressing need for new economic models that can enhance resource efficiency and effectiveness (Ghisellini et al., 2018).

The COVID-19 pandemic has had a significant impact on the global economy for over two years. It has led to an economic downturn and the onset of a crisis. The pandemic caused disruptions in global supply chains, resulting in a slowdown in production, industry, and trade worldwide. Unemployment rates increased, and small and medium-sized enterprises (SMEs) were particularly hard-hit.

In 2020, the Czech Republic experienced the largest decline in gross domestic product (GDP) in its history, with a contraction of 5.6%. However, the year-on-year decline was moderated to 4.7% due to foreign demand. Furthermore, the state debt increased to 36.5% of GDP in 2020, compared to 28.5% in 2019. The state budget deficit in 2020 reached CZK 367.4 billion, significantly surpassing the planned CZK 40 billion deficit. The deficit was observed throughout the year, with the highest levels occurring during the spring and autumn months, likely due to stringent government restrictions. State budget revenues decreased by 3.1% due to tax reliefs (ČSÚ, 2021).

The aim of this paper is to analyze the financial data of companies obtained from balance sheets and profit and loss statements in the pre-pandemic and pandemic periods. Two hypotheses are set to fulfill the objective: H1: Balance sheet indicators (some items of assets and liabilities) show a different trend during the pandemic period. H2: Values from income statements (some items of costs, revenues, and profit and loss) or cash flow exhibit a different trend during the pandemic period.

## 2. Methodology

The data for the analysis were gathered from two sources. In the initial phase, it was necessary to determine whether the companies under study had implemented elements of the circular economy or not. This information was collected through questionnaire surveys, creating a proportional sample of over 12,900 enterprises to match the distribution in the Czech Republic. In 2020, data were obtained from 245 companies, representing an almost 2% response rate. The companies were then classified based on their engagement with the circular economy. Out of the total 245 analyzed enterprises, it was found that 102 had implemented elements of circular economics, while 143 had not.

In the subsequent steps (in the years 2021 and 2022), the accounting data values were determined for these classified companies using the Albertina Gold Edition database. However, financial data could only be obtained from 160 out of the 245 companies. The companies were further categorized based on the implementation of circular economy elements for research purposes, resulting in 84 companies without implemented elements and 76 companies with implemented elements. The relationship between these factors was then analyzed using a statistical Mann-Whitney U test. This test is used to evaluate unpaired experiments when comparing two different samples. It was tested the hypothesis that two variables have the same probability distribution. At the same time, these variables may not correspond to Gaussian normal distribution, it is sufficient to assume that they are continuous. The test involves the calculation of a statistic, usually called U, whose distribution under the null hypothesis is known. U is then given by (Devore, 2015):

$$U_1 = R_1 - \frac{n_1(n_1 + 1)}{2} \quad (1)$$

where  $n_i$  is the sample size for sample 1, and  $R_i$  is the sum of the ranks in sample 1. An equally valid formula for U is:

$$U_2 = R_2 - \frac{n_2(n_2 + 1)}{2} \quad (2)$$

The smaller value of U1 and U2 is the one used when consulting significance tables. The sum of the two values is given by:

$$U_1 + U_2 = R_1 - \frac{n_1(n_1 + 1)}{2} + R_2 - \frac{n_2(n_2 + 1)}{2} \quad (3)$$

Knowing that  $R_1 + R_2 = \frac{N(N+1)}{2}$  and  $N = n_1 + n_2$ , and doing some algebra, we find that the sum is  $U_1 + U_2 = n_1 n_2$ .

It was tested the hypothesis  $H_0: \vartheta_1 - \vartheta_2 = 0$  against the alternative one.

### 3. Results

As mentioned above, the data for the analysis were obtained from two sources - the first source was a questionnaire (the questionnaire found out which companies have, and which do not have implemented elements of circular economy) and the database as a second source to obtain accounting data from these companies. Based on the Mann-Whitney U Test, the accounting data of companies with the implementation of elements of the circular economy were statistically analyzed for the years 2019 and 2020. These years were selected as sample years, with 2019 including accounting data from the pre-pandemic period and 2020 including accounting data from the pandemic period. The level of significance was determined to  $p = 0.05$ .

#### 3.1. Analysis of Differences in Selected Accounting Items of Assets and Liabilities in 2019 and 2020

Within the research, statistically significant differences in the data between the two periods were examined. The analysis focused on the following aspects of the accounting data: a) assets and liabilities, and b) costs, revenues, profit and loss, and cash flow. In the first part of the analysis, a total of 42 active and passive items from the balance sheet were examined. The following table (Table 1) presents the 14 most significant items selected from this group. This analysis is key to understanding changes in the structure of assets and liabilities, which helps to identify key factors influencing the company's results in given periods. The results of the analysis indicate potential strategic points on which the company could focus its attention in order to optimize its financial results in the future.

From Table 1, it can be concluded that the only statistically significant difference at a significance level of p-value 0.05 is observed for the indicator of long-term financial assets. Looking at the graphical representation, it is evident that the values of this indicator are higher during the pandemic period, i.e., in 2020. This could be attributed to the fact that companies were unable to conduct their operations as usual during this period and, therefore, they invested their available funds in the form of long-term deposits. If we were to adjust the significance level to a value of p-value 0.10, the indicator of capital funds would also become statistically significant. Once again, the graphical representation shows that the accounting value of capital funds is higher in 2020. Thus, H1 has been confirmed. It is seen the differences in Figure 1. Higher values of the indicator of long-term financial assets during the pandemic

Table 1. Differences in selected accounting items of assets and liabilities in 2019 and 2020

| Financial indicator        | Year 2019 | Year 2020 | U     | Z       | p-value |
|----------------------------|-----------|-----------|-------|---------|---------|
| Total assets               | 5,862     | 5,766     | 2,840 | 0.1750  | 0.8611  |
| Long-term tangible assets  | 5,264     | 5,032     | 2,476 | 0.3210  | 0.7482  |
| Long-term financial assets | 689       | 742       | 224   | 1.9625  | 0.0306  |
| Current assets             | 5,754     | 5,874     | 2,828 | -0.2193 | 0.8265  |
| Stocks                     | 4,855     | 4,875     | 2,370 | -0.1875 | 0.8513  |
| Trade receivables          | 5,792     | 5,836     | 2,866 | -0.0792 | 0.9369  |
| Current financial assets   | 5,647     | 5,981     | 2,721 | -0.6135 | 0.5395  |
| Equities/Liabilities       | 5,862     | 5,766     | 2,840 | 0.1750  | 0.8611  |
| Owner's equity             | 5,678     | 5,950     | 2,752 | -0.4993 | 0.6176  |
| Capital funds              | 1,851     | 2,154     | 770   | -1.7939 | 0.0728  |
| Total liabilities          | 5,884     | 5,744     | 2,818 | 0.2561  | 0.7979  |
| Debts                      | 5,822     | 5,806     | 2,880 | 0.0276  | 0.9780  |
| Trade debts/liabilities    | 5,658     | 5,970     | 2,732 | -0.5730 | 0.5666  |
| Bank and other loans       | 5,878     | 5,750     | 2,824 | 0.2340  | 0.8150  |

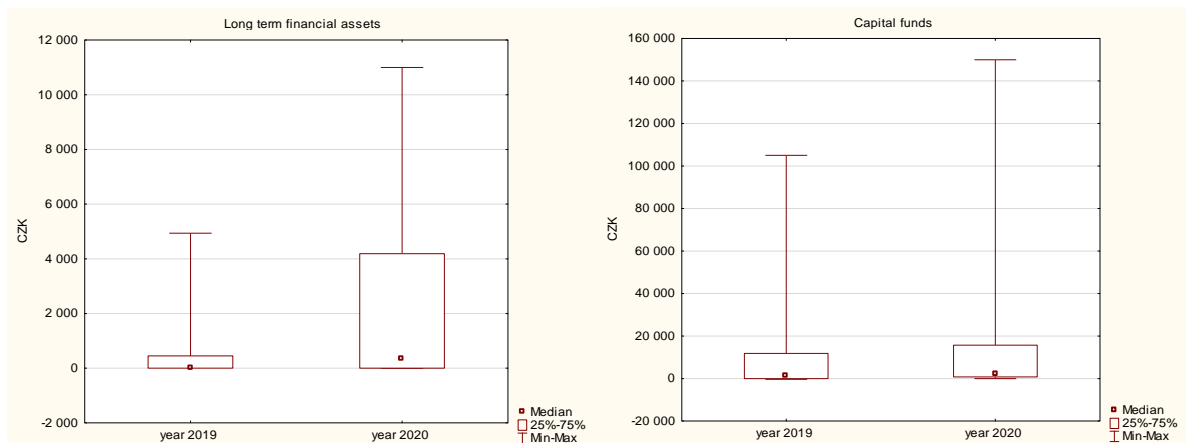


Figure 1. Differences in items long term financial assets (on the left) and capital funds (on the right) in 2019 and 2020

period in 2020 can be interpreted as a reaction of companies to the impossibility of running their normal operations. With limited business opportunities and an uncertain environment, companies probably preferred to invest in long-term deposits as a stable and safe way to appreciate available funds. This move could serve as a temporary measure to maintain asset value and minimize risks in an uncertain economic environment, which explains the observed significant difference in this accounting ratio.

### 3.2. Analysis of Differences in Selected Accounting Items of Costs, Revenues and Cash Flow in 2019 and 2020

In the second part, 46 items from the profit and loss statement were examined, specifically cost and revenue items, as well as the profit and loss and cash flow value. The following table presents the 14 most significant items selected from this group.

Table 2. Differences in selected accounting items of costs, revenues and cash flow in 2019 and 2020

| Financial indicator                               | Year 2019 | Year 2020 | U     | Z       | p-value |
|---|-----------|-----------|-------|---------|---------|
| Material and energy consumption                   | 3,581     | 3,440     | 1,610 | 0.6971  | 0.4857  |
| Total consumption                                 | 4,862     | 4,454     | 2,108 | 0.8857  | 0.3758  |
| Other revenues from operating activities          | 6,366     | 5,262     | 2,336 | 2.0322  | 0.0421  |
| Revenues from the goods and services sold         | 5,798     | 5,830     | 2,872 | -0.0571 | 0.9545  |
| Labor costs                                       | 5,638     | 5,990     | 2,712 | -0.6467 | 0.5178  |
| Revenues from the fixed assets and materials sold | 5,928     | 5,700     | 2,774 | 0.4182  | 0.6758  |
| Residual cost of fixed assets and materials sold  | 6,312     | 5,316     | 2,390 | 1.8333  | 0.0668  |
| Operating costs                                   | 5,756     | 5,872     | 2,830 | -0.2119 | 0.8322  |
| Interest income                                   | 2,569     | 2,582     | 973   | 1.9576  | 0.0503  |
| Interest expense                                  | 2,744     | 2,612     | 1,286 | 0.2605  | 0.7944  |
| EBT   | 5,776     | 5,852     | 2,850 | -0.1382 | 0.8901  |
| Total financial costs                             | 5,744     | 5,884     | 2,818 | -0.2561 | 0.7979  |
| Total financial revenues                          | 5,418     | 6,210     | 2,492 | -1.4574 | 0.1450  |
| Cash flow   | 5,650     | 5,978     | 2,724 | -0.6025 | 0.5468  |

From the table above, it can be seen that at a significance level of p-value 0.05, there is a statistically significant difference only for the indicator of other revenues from operating activities. When graphically representing this indicator, it is found that its values are lower and in some cases the companies were also incurring significant losses during the pandemic period as you can see it in Figure 2. This could be because companies were unable to sell their products, goods or services and generate revenue.

If we adjust the significance level to a p-value 0.10, the indicators of residual cost of fixed assets and materials sold, as well as the indicator of interest income, would also become statistically significant. Looking at the graphical representation, it can be observed that the accounting value of residual cost was lower in 2020. This may indicate that some companies were forced to sell certain long-term assets or inventory. As for the interest income indicator, it is evident that the interest rates were higher in 2020. This could be attributed to the fact that companies invested in long-term financial assets instead of their own business activities, and these long-term assets generated interest income for them.

The aforementioned analysis shows that during the pandemic period, companies may have faced challenges in generating income from other operating activities, which is reflected in the statistically significant difference in the indicator of other income. H2 has been confirmed.

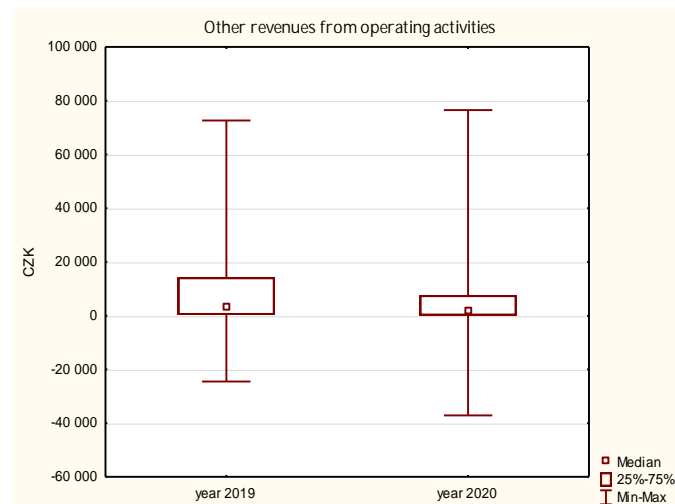


Figure 2. Differences in item other revenues from operating activities in 2019 and 2020

#### 4. Discussion

Circular economy signifies minimizing waste and optimizing resource utilization through reuse, recycling, and material recovery. Vičková (2020) analyzed indicators in relation to individual elements of the circular economy, which are backup of plastic packaging, increasing the life of packaging; recycling and reuse of waste; and use of renewable resources. In the analysis of financial indicators and the recycling and reuse of waste element, a significant difference was found in the liability's indicator. When analyzing the use of renewable resources element, a difference was found in the fixed assets indicator. In the analysis of the element of backup of plastic packaging, increasing the life of packaging, a significant difference was found in the owner's equity indicator, total assets, operating revenues, and operating costs indicators. All these indicators were lower for companies that have implemented the elements of the circular economy.

This paper focuses on the analysis of accounting data for companies that are affected by the circular economy in the period before the pandemic and during the pandemic. The observed statistically significant differences imply that the period of the pandemic had a notable influence on the financial and operational functioning of businesses, requiring them to adjust to new circumstances and make strategic investments in long-term assets. These fluctuations in indicators indicate the importance of adapting and refining business strategies to effectively respond to the arising challenges.

From the analysis, it can be concluded that during the pandemic period, companies may have faced difficulties in generating income from other operating activities, which was reflected in a significant statistical difference in the indicator of other income. Similarly, Kuo et al. (2010) found a positive correlation with statistical significance in terms of the company's environmental costs, net income, and economic benefits of environmental protection. Regarding the circular economy as such, Franklin-Johnson et al. (2016) focus on the development of novel indicators to assess the environmental impacts associated with the circular economy. They specifically examine a new performance metric called the lifetime indicator, which quantifies the contribution to material retention by measuring the duration

of resource reuse. These performance indicators serve as valuable tools at the management level, enabling the measurement of decision impacts on the longevity of renewable materials.

Scarpellini et al. (2021) highlight the significance of financial resources as a critical factor for investments in the circular economy. They emphasize that from an economic standpoint, barriers to investment are often linked to low levels of profitability and challenges in accessing financing, particularly in certain countries. These factors can hinder the adoption and implementation of circular economy practices and initiatives. As this analysis implements, in the pandemic period these phenomena are further deepened, and risks increase.

The circular economy is not only about accounting data. As with any theory, the circular economy is not without its critics. One of the main criticisms is that the circular economy often overlooks the social dimension, including issues related to gender and racial equality, fair financial evaluation, intergenerational equality, and equal employment opportunities. Critics also highlight the challenges associated with recycling certain materials, such as wind turbines and solar panels, due to their complex composition. Additionally, from a thermodynamic perspective, recycling is criticized because materials tend to degrade in quality and quantity with each subsequent cycle (Rizos et al., 2017).

For future research, it is recommended to analyze the impact of the economic circulation on enterprises in connection with accounting data, with an emphasis on categorizing companies into manufacturing companies, service providers and business companies. This categorization could provide a deeper insight into specific challenges and benefits of the economy in various sectors. Furthermore, it would be useful to examine how different types of companies deal with the principles of the economy circulation and how these changes are reflected in accounting data. Analysis could include the evaluation of the efficiency of the economic circulation in each type of enterprises and identifying areas where sustainability and efficiency can be improved. In addition, the role of accounting indicators could be examined in measuring the performance of companies within the principles of the economy circulation. Taking various branches and types of enterprises, the results could become more specific and applying for specific areas of business.

## 5. Conclusions

Access to renewable resources, waste minimization and efficient use of resources can play a key role in optimizing costs and increasing sustainability. The implementation of circular practices could lead to innovative approaches to financing and investments that would not only reduce the environmental impact of companies, but also bring economic benefits.

Overall, it can be concluded from the analysis that the impact of the pandemic period on companies was manifested by significant differences in accounting data. The first part of the analysis focused on active and passive items of the balance sheet showed that the only statistically significant difference at the significance level of 0.05 was observed for the indicator of long-term financial assets. This difference can be interpreted as the response of companies to the limitation of normal operations during the pandemic period, when investments shifted to long-term deposits as a stable and safe way of evaluating available funds.



The second part of the analysis focused on the profit and loss statement confirmed a statistically significant difference at the same level of significance only for the indicator of other income from operating activities. A graphical representation of this indicator showed that the values were lower, which may be a consequence of the difficulties of firms in generating income from other operational activities during the pandemic. Adjusting the level of significance to 0.10 revealed statistically significant differences also for Residual cost of fixed assets and materials sold and interest income indicators. Lower residual cost values in 2020 may signal the need to sell long-term assets or inventory. Overall, therefore, the analysis suggests that businesses faced challenges in generating revenue during the pandemic period and responded by changing their finance and investment strategies.

Given the growing interest in sustainability and environmental responsibility, further research could examine how firms integrate circular principles into their financial strategies and how these changes affect their performance and results in turbulent times.

Conflict of interest: none.

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