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AND POST-DOCTORAL SCHOLARS

COVID-19 Recovery: The Need for Speed

UNIVERSITY OF ECONOMICS IN BRATISLAVA,
SLOVAK REPUBLIC

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COVID-19 Recovery: The Need for Speed

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Foreword

The year 2021 has been the year our university has successfully completed the process of AACSB accreditation and proudly popped up **among the 6% of business and management faculties and universities worldwide** recognized with this prestigious label. The accreditation process was the time of change: for faculty staff, for students, for management as well as for stakeholders, yet the past two years the pace of change accelerated. One reason for that was also the booming global demand for teleworking, digitalization, and climate neutral solutions amidst COVID-19 pandemic.

In such challenging times, I believe some fresh new idea might help to gain better perspective on the economic life than a series of scholarly work burdened by years of experience. The EDAMBA conference is one of those occasions to dig into those ideas and bring them to scholarly attention. That is why the 24th International Scientific Conference for Doctoral Students and Post-Doctoral Scholars EDAMBA bore the title COVID-19 recovery: The need for speed.

The 2021 edition of EDAMBA conference hosted Professor Francois Gemenne from University Liege and Professor Julius Horvath from Central European University, Vienna whose keynote addresses were meant to inspire the debate around these issues. On one side, Professor Gemenne challenged the impact the UN Climate Change Conference COP26 in Glasgow had amidst the pandemic and the need for climate resilient economic recovery. On another side, Professor Horvath elaborated on the limits of post-covid recovery considering the differences in economic thought and in economic performance between Western and Central/Eastern Europe. The subsequent sessions presentations evolved around following topics:

1. Sustainable production and consumption - a challenge for management and business
2. New trends in trade and marketing
3. Current challenges on tourism
4. Theory and Application of Quantitative Methods in Economics and Management
5. The Present and the Future of Accounting and Auditing
6. Impact of the COVID-19 pandemic on the economy of the Slovak Republic
7. From better economics to better economy
8. Sustainable growth in the context of changes in the global world
9. Migration and the European Union

Proudly we present herewith the proceedings of the conference and hope that diverse as they are, they still are going to provide valuable insights into the more puzzling world and make enjoyable and inspiring reading.

Paula Puškárová

Conference Chair

Vice-Rector for Research and Doctoral Studies

University of Economics in Bratislava

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IMPACT OF COVID-19 ON VALUATION OF SLOVAK COMPANIES

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Abstract. At the end of 2019, the first case of a virus, named SARS-CoV-2 (COVID), was confirmed in Wuhan, China. Over the next few months, the virus spread around the world and began to affect all areas of our life. An important role in the fight against the disease is played by the restriction of social contacts, which the governments of most states implement in the form of restrictions at various levels. Restricting the international and domestic market significantly affect the current development of foreign and domestic production and transport, which has a negative impact on the global economy and specific impacts on the economy of the vast majority of countries, including the EU and the Slovak Republic. As a result of the COVID pandemic, countries all around the globe have taken some kinds of measures that have resulted in limiting the self-employed and business in their economic and financial operations. If they do not have sufficient financial reserves and their main source of income is limited due to different anti-pandemic measures, sooner or later they will be forced to decide what will happen with their business. The aim of the article is to point out the impacts of a COVID pandemic on the Slovak economy and the changes it brought within the perception of valuation of companies in Slovakia.

Keywords: COVID-19, valuation, capital structure.

JEL classification: *O44*

1 Impact of COVID-19

At the end of 2019, the first case of a then-new and unknown virus, named SARS-CoV-2, was confirmed in Wuhan, China. At that time, no one knew what the consequences

of this virus would be for the whole world. Over the next few months, the virus spread around the world and began to affect daily life.

Most countries are trying to combat the ongoing pandemic, both together and through their own measures, to a greater or lesser extent within countries. An important role in the fight against the disease is played by the restriction of social contacts, which the governments of most states implement in the form of restrictions at various levels, especially in the areas of trade and services, education and training, cultural and leisure activities. Governments ordered the wearing of veils and respirators, closed shops, disrupted cultural events, and ordered many other measures. This restriction of everyday life has led to economic decline. Restricting the international and domestic market significantly affect the current development of foreign and domestic production and transport, which has a negative impact on the global economy and specific impacts on the economy of the vast majority of countries, including the EU and the Slovak Republic.

The financial and capital markets are also closely related to the economy. They also experienced the biggest slump since the financial crisis in 2008 last March. For this reason, governments and central banks have begun to intervene to restart the economy.

For more than a year, the Slovak Republic has been struggling to fight several waves of pandemics, where different perspectives on crisis management can be beneficial for Slovak and multinational companies, especially if they include more comprehensive approaches and the implementation of effective measures. Currently, companies are trying to respond to government regulations, which does not always lead to an optimal response. Most companies face new experiences and situations that are unknown to them and the outcome of which is difficult to predict. Thus, in each economic sector and sector, a different change in the behavior of companies can be expected depending on their specific conditions.

2 Literature review- effect of coronavirus pandemic on financial markets

A coronavirus pandemic has affected the lives of people around the world for more than a year. During this time, many academic papers have been created dealing with the effects of coronavirus on many aspects of our lives, such as leisure, finances, etc. financial markets.

Most of the studies dealt with the impact of the spread of the disease on the financial markets. This primarily means an increase in the number of infected and the number of deaths. [4] examined how the spread of COVID-19 affects financial markets in China and the United States. COVID-19 had a positive effect on the markets.

[5] also confirmed the positive influence, which surveyed the behavior of the volatility of the US dollar exchange rate against three foreign currencies under the influence of rising diseases and deaths on COVID-19. During the observed period, the coronavirus had a positive effect on volatility.

However, most of the work confirmed that the pandemic had a rather negative effect. [6] examined the effect of the number of infected on the volatility of financial markets and exchange rates within the Visegrad Group Countries. The work confirmed that the currencies of the Visegrad Group Countries depreciated and volatility in financial markets increased.

[7] examined whether the increase in COVID-19 deaths affects financial markets. Indeed, the growth in deaths increased volatility and reduced the profitability of the markets examined.

[8] examined how the growth of those infected affects the financial markets of developing countries (emerging markets). Coronavirus has had a negative effect on these markets. The impact was stronger if the governments of these countries did not implement fiscal stimulus.

The study by [9] tested how the number of infected affected global financial markets. Coronavirus has had a predominantly negative effect on markets.

[10] examined a link between the spread of coronavirus and volatility in oil markets with US stock markets and the political and economic situation in the US. Their results showed a correlation between COVID-19 disease and uncertainty in US markets.

[11] examined the effects of a pandemic in the form of growth infected on the US stock and oil markets. The results show that the coronavirus had a positive effect on the profitability of these US markets.

[12] examined the effect of the spread of the COVID-19 pandemic on market volatility. He investigated whether the VIX index was affected by infections and mortality on COVID-19 in China, outside China, and overall. The author also examined whether the number of infected countries also affected the implied volatility in the markets. The VIX index was not affected by any new additions infected in China or together, only those outside China. The VIX Index responded to mortality from COVID-19 in China, including overall mortality. The development of the number of infected states also played a role in the development of the VIX index.

[13] observed differences in the volatility of US financial markets and commodity markets before and during a pandemic. Increases in volatility were measured during the pandemic.

[14] compared the impact of current pandemics and past pandemics on financial market volatility. According to their results, the current pandemic has a strong and negative effect on volatility, while previous pandemics have had almost no effect.

[15] followed the change in volatility in financial markets before and during the pandemic. The result is increased market volatility.

[16] looked at profitability and volatility in the US. Companies operating in the healthcare, food and technical stocks recorded growth in profitability, while shares of companies in the entertainment industry or the real estate market saw a decline in profitability and increased volatility.

[17] monitored the profitability of world markets. COVID-19 had a negative effect on their profitability.

[18] examined profitability in the US, Europe and Asia markets. Markets worldwide have fallen, most in the US. They recovered the fastest in Asia, the slowest in Europe.

Studies have also been carried out to examine whether certain state interventions affect financial markets.

[19] examined whether the increase in the number of new cases of COVID-19 and the number of deaths from this disease affects the profitability of global financial markets. During this period, the financial markets reacted negatively to the growth of new cases of COVID-19 and to death.

This study was followed by [20], which examined whether the profitability of financial markets was affected not only by the growth in the number of new daily cases but also by government regulations divided into three groups. The first group included regulations related to the observance of social distances, such as school closures, shops, restrictions on gatherings, etc. The second group of regulations related to tracing, testing citizens, and awareness-raising campaigns about the virus. The last group concentrated economic regulation to help with wage shortages and household debt forgiveness. All these groups have still been tested to see if they have an indirect impact on the markets despite the change in the growth in the number of new daily cases of COVID-19. Regulations on social divergence have a twofold effect on markets, the direct effect is negative (due to the artificial reduction of economic activity) and the indirect effect is positive, as they reduce the number of daily increments. Regulations related to testing, tracing, and awareness-raising campaigns had only a positive direct effect, they did not indirectly affect the profitability of markets. Economic regulations had no significant effect on financial markets.

[21] examined whether government regulations such as travel incentives or bans and ordered lockdowns affect stock markets. The results show that these regulations have helped global stock markets.

[22] examined whether government interventions affect the realized volatility of financial markets. As interventions, they used interventions such as closing schools and shops, canceling cultural events, checks on international travel, etc. The study showed that the observed volatility in the markets over the observed period reacted negatively (increased) to government interventions. The disruption of public events and the information campaign on the coronavirus pandemic had the strongest effect.

There are also works that have examined people's fears of a pandemic by searching for certain phrases or the influence of the media.

[23] examined whether the intensity of Google word searches and phrases related to the new COVID-19 disease (corona, pandemic, symptom, lockdown,...) affects the realized volatility of financial markets. Ten countries were selected for the survey, in which both volatility and search intensity were examined. It was examined whether the intensity of the search has an effect on a specific state and other selected states. The result of their work is that the intensity of searching for phrases related to the COVID-19 pandemic in a particular state and in other states affects the realized volatility of financial markets. Volatility increased due to this effect, which caused more uncertainty in the markets.

[24] examined the effect of coronavirus searches on Google on financial market volatility. Their results say that increased search intensity has also increased volatility in markets in Europe, Asia, the United States and Australia. At the same time, the negative effect of coronavirus on the economy reinforced this effect.

[25] compared the effect of the spread of the disease and the fear of searching for coronavirus on Google on the profitability of markets. The search had a stronger negative impact on the markets, which was amplified by the growth in the number of infected.

[26] tested whether US financial market volatility is affected by media and news related to coronavirus. News from coronavirus has resulted in increased market volatility.

There are also studies that have examined whether the size of trust in the state institutions and other fellow citizens during the pandemic also affects the financial markets. For example, [27] in their study examined whether people's trust in government during the COVID-19 pandemic affects volatility in financial markets. In their work, they found out whether citizens trust the government and fellow citizens. Subsequently, these states were divided into two halves according to the level of trust. They observed a relationship of trust and volatility for the period from 22 January to 28 July and for a shortened period when the pandemic intensified, from 22 January to 3 May. First, they examined the differences between countries with the higher trust in government and countries with the lower trust in government. tests showed that in countries with higher trust in government and trust in fellow citizens during the shortened period, volatility was indeed on average lower than in countries with lower trust in government.

The need of the company for external resources is increasing due to the lack of cash flows resulting from the COVID pandemic. This is due to the fact that all business activities are forced to stop in order to constrain further spreading of the virus. This resulted in a number of companies that are negatively affected by the pandemic, that are seeking additional financial resources to cope with their lack of liquidity.

A result from a study [42] shows that from the beginning of the COVID pandemic the bond market has become more active.

[43] and [44] further document that during the pandemic is increased the drawdown of bank loans and the drawdown of credit lines.

The ability of companies to borrow either on the capital markets or from banks is influenced by their debt capacity, If the company applied a conservative debt policy that protects financial flexibility, they can finance new investments with new debt issues [45].

Keeping financial leverage low therefore provides greater debt capacity and financial flexibility, which gives the companies concrete benefits during a market downturn.

[46] present that firms with high financial flexibility show a lesser decrease in their market value due to COVID-19 than firms with low financial flexibility. In this case, the company has more debt, so it is exposed to higher risk than the company with less debt because the financial leverage effect is significantly positively correlated with the volatility of stock returns.

3 Impacts of a pandemic on the Slovak economy

The economic impact of the pandemic on EU industries is addressed in a study that provides estimates of the global costs of a pandemic crisis on projected GDP growth in 30 different countries according to different scenarios. The author assumes that the economic impacts of the Covid-19 pandemic are currently underestimated compared to the impact of the SARS epidemic or financial crisis in 2008/2009 [1].

Of the European countries, the pandemic has negatively affected mainly the economies of service-oriented countries, which were also endangered in terms of jobs. Tourism-dependent countries such as Greece, Portugal, and Spain have been hardest hit by the pandemic crisis. The current economic crisis is also affecting supply chains. Therefore, the economies of countries more dependent on foreign trade are more affected. The study shows that the current pandemic crisis costs an average of 2.5-3% of global GDP each month.

According to [2] there was a gradual slowdown of the economy in the EU countries as early as 2019. Germany in particular, affected by the decline in global demand for cars, could not recover from the gradual decline in production. Structurally the weakest economy in the euro area was Italy, whose growth potential was close to zero. The hope for 2020 was to ease tensions in international trade.

For many years, Slovakia has served as an example of an economy with minimal macroeconomic imbalances and strong financial stability. The trade balance maintained a solid surplus and the current account of the balance of payments ended in a slight deficit in 2019 only due to high dividends paid abroad. The debt of Slovakia in relation to GDP was relatively low until 2020. The financial sector was relatively strong in terms of capital. Slovak GDP in 2020 fell by 5.2 percent [3]. Towards the end of the year, the economy was helped by exports and reducing the downturn in some sectors.

The economic downturn in the fourth quarter was the second mildest last year, reaching 2.7 percent (Fig.1). The growth of value added in several sectors, especially in industry in the last months of the year, was dampened by the unfavorable trend from the first half of the year.

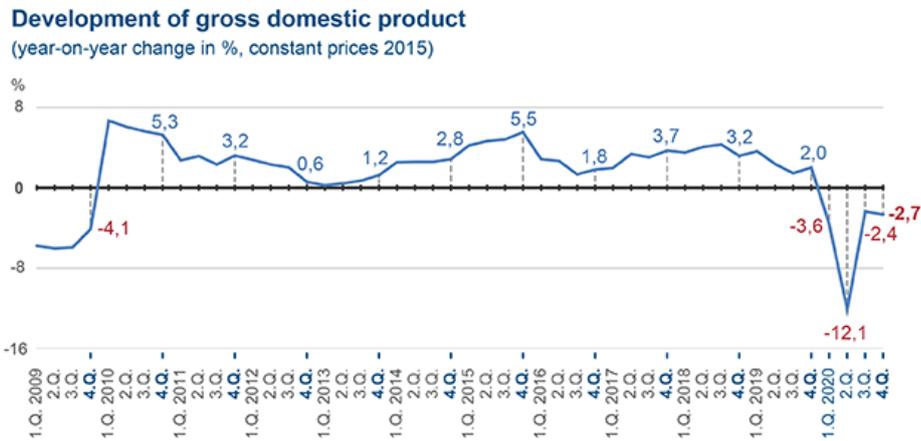


Fig. 1 Development of gross domestic product of the Slovak Republic [3]

Compared to the third quarter, the gross domestic product in Slovakia was seasonally adjusted by 0.2 percent higher in real terms. At current prices, it reached 24.1 billion euros, which is 0.4 percent lower than in the fourth quarter of 2019 [3].

The first wave of the Covid-19 pandemic caused historical declines in key indicators in the second quarter, but at the end of the year the economy was able to start despite the second wave of the pandemic and showed the second slightest decline in 2020. Growing external demand again played a key role in the result.

The activity of individual sectors in the 4th quarter was affected to a different extent by the pandemic. The most significant year-on-year decrease in value added was in construction by 13.8 percent. The double-digit decline was still reflected in wholesale, retail trade, transport and storage, accommodation and food services, as well as in financial and insurance activities [3].

Value added growth was mainly in industry by 2.7 percent, in public administration, education, health and social work by 2.5 percent and in real estate activities by 1.9 percent.

At the beginning of the pandemic, the negative effects on the economy hit mainly the countries where the disease spread the fastest, such as Italy and Spain. In 2020, a number of sectors in EU countries were gradually paralyzed, such as retail, sports, culture, education, libraries, air transport, catering, and accommodation, or travel agencies, which account for around 10 percent of GDP. However, other sectors of the economy are linked to these sectors. It is currently very difficult to quantify the effects of a pandemic, as evidenced by the economic recession of 2012 and 2013.

Last but not least, the disruption of global value chains needs to be mentioned.

Slovak companies are largely involved in complex chains with a high specialization of articles. Slovak companies make intensive use of imported intermediate products in their production.

Strong involvement in international trade brings with it higher revenues, but also greater shocks in the global economy. The spread of the pandemic across Europe and dramatic preventive measures were a significant intervention in the economy of Slovak companies. It was mainly a cessation of production in the automotive industry, as it is connected to a wide chain of suppliers from other industries.

In recent history, an unknown, in many respects unprecedented situation, which first affected the health system and then the entire economy of all affected countries. The historical view of the greatest economic crisis of modern times knows no such case in which a considerable part of economic activity has been practically stopped or minimally limited. This crisis is unique to individual economies in that it combines an internal shock associated with the closure of some service outlets, retail and production interruptions, with an external shock associated with supply chain disruptions and a slump in external demand. Although this type of crisis is more or less unknown, most experts agree on how to defend against a pandemic crisis.

The defense should be the fiscal policy response, which must be as fast as possible, strong enough, targeted, and, above all, should bring a sufficient degree of confidence to the economy.

[31] further states that in the short term it should be aid mainly to support small and medium-sized enterprises and employment. A specific form of assistance for small and medium-sized enterprises should be, for example, in the form of the supply of the necessary liquidity, the shift, reduction or remission of taxes and social security payments. Employment should be supported by at least partial payment of the salaries of employees who are unable to work due to the pandemic. Further support for households could be a targeted one-off financial contribution to help them overcome the problems of paying rents, loans, and common needs. Further important assistance should go to the financial system, which is most likely to face a higher level of non-performing loans, thus preventing the crisis from entering the financial system. The timing of aid is very important, which must be urgent and without unnecessary bureaucratic obstacles. This is the only way to prevent a catastrophic scenario that may occur shortly after the pandemic.

Central banks, governments and supervisors reacted strongly to the situation. Central banks promptly adopted a package of stabilization measures, the scope and especially the intensity of which are unprecedented in the past. Thanks to them, the price falls stopped at the end of March 2020 and the markets saw a partial correction. Supportive measures by national governments, aimed in particular at maintaining employment and improving the situation in the business environment, have made a significant contribution to mitigating the impact on the real economy. In several countries, already two months after the outbreak of the pandemic, the amount of promised state aid exceeds the amount used during the previous financial crisis [32].

Even prompt fiscal and monetary stimulus does not change the fact that the world will almost certainly plunge into a severe economic recession in the near future. One of the main problems is the uncertainty regarding its depth, duration and possible

consequences of a more permanent nature. A separate problem for the economic recovery is perhaps the wave of a coronavirus pandemic.

The most significant risk are losses from non-performing loans. The profitability of financial institutions, especially banks, will fall sharply. Despite the significant risks that financial institutions will face in the coming period, the resilience of the banking and insurance sectors as a whole is at a high level.

Banks currently have enough capital and liquidity to continue lending. On the other hand, some households and companies already had a relatively tense financial situation with a low level of savings when entering the crisis, which the NBS has repeatedly pointed out in the past. Due to the high uncertainty about the impact of future economic developments on the financial situation of clients, banks will be significantly more cautious in providing loans. This can be particularly problematic for businesses that need to bridge the temporary loss of income through short-term bank loans [32].

From the point of view of financial stability, it is important to what extent the financial sector will be able to provide financial services, including economic lending, during the economic shock. It depends on whether the financial sector will support the early recovery of the economy or, conversely, the problems associated with the spread of coronavirus will exacerbate.

This will be particularly important from the point of view of companies that need additional funding to bridge the temporary loss of income. The main impact will be the banks' fears of an increase in non-performing loans.

For corporate loans, banks have tightened lending standards to the greatest extent since the financial crisis in 2008, and even more significant tightening is expected in the coming period. However, the conditions for providing retail loans have also been tightened, especially for self-employed persons and employees in the most affected economic sectors. On the other hand, sufficient capital and liquidity do not currently represent a significant constraint. Banks have enough capital to maintain them in the coming years credit growth rate of 2019.

4 Forms of valuation of companies in Slovakia

Valuation of a company is a specific process in which various experts from different fields are involved. The question is what are the purposes of determining company value?

The company should know how it will develop and what the future brings. This may lead to a situation when the company owner should determine whether to sell, liquidate or merge the company. If a business owner opts for a merger of his company, he should know its value in order to evaluate if the merger is advantageous or not. To determine this value, the authors recommend analyzing the internal environment of the company, which is consequently affected by the fluctuations in its macroeconomic and microeconomic surroundings [33].

We can show this with an example of the influence that the current COVID pandemic situation, has on the global economic market.

As a result of the COVID pandemic, countries all around the globe have taken some kinds of measures that have resulted in limiting the self-employed and business in their economic and financial operations. If they do not have sufficient financial reserves and their main source of income is limited due to different anti-pandemic measures, sooner or later they will be forced to decide what will happen with their business [34].

Simulating the value of a company and its capital structure under the influence of taxes, risk, and possibilities to grow shows that there are unique optimal levers for each combination of the above-mentioned factors. In order to determine the value of the company in the period when the decision for the future of the company is needed, we must understand the factors that affect the company value [35].

A company's financial valuation is a complex process in which professionals from different fields are involved in expressing the company's value using a monetary amount. It can be valued as a whole, or only some parts of the company can be evaluated [36].

There are different methods of determining the firm value, which is interesting for various stakeholders (investors, owners, and creditors). The main point of interest is the market price of the company – referred to as the market value [37]

A company cannot afford to be freely driven by external influences and events alone, so planning is a very important activity, in order to withstand a turbulent environment.

Companies that plan ahead, are better prepared for various situations and the uncertainty of the future threats, and thus can easier respond to them [38]

According to [39] in the period of the COVID pandemic, there are two most common valuation methods. One of the methods is based on economic value added (EVA), linked with the stock prices.

The second method [39] is the discounted cash flow (DCF) method. The preference of the DFC method of valuation during the COVID pandemics is confirmed by [40] and is the most widely used method used in practice, as confirmed by [41].

Valuation is mainly based on one of the three main approaches: the income, market and cost (or asset). Although each of these approaches has its pros and cons, valuation experts place much more emphasis (based on the impact of Covid-19 on economy) to the discounted cash flow (DCF) method, a variation of the income approach, given its direct significance to the entity being valued [30].

As one of the basic problems in the valuation of companies in Slovakia, are the challenges of choosing the right method of valuing the company. It is useless to be able to work with one method, to be able to apply it perfectly, to compare it, and on the other hand to apply it to a company that is unsuitable for this method. For example, to use the discounted dividend method to value a company that does not pay dividends, or pays them irregularly, exceptionally, and at different amounts, if we are talking about a very simple example. We have managed to find several divisions and forms of valuation in the literature, related to the conditions in Slovak economy:

a) Five valuation methods according to the Decree of the Ministry of Justice of the Slovak Republic [28]:

- Asset method in which an expert determines the general value of an enterprise and parts of an enterprise by summing the general values of the various components of the enterprise's assets minus the general value of borrowings at the current date.

- The business method, where the expert determines the general value of the company and parts of the company by capitalizing the extractable resources for the evaluated period of the business.

- A combined method, where the expert determines the general value of the enterprise and parts of the enterprise as a weighted average of the general values of the enterprise determined by the asset and business method.

- Liquidation method, where the expert determines the general value of the company and the part of the company at the dissolution of the legal entity associated with liquidation, as the sum of general values of assets of the company taking into account the general value of foreign resources and liquidation values of the components of the company's assets objectified by the coefficient of monetization.

- A comparative method where the expert determines the general value of the enterprise and the parts of the enterprise taking into account selected common criteria of a set of comparable enterprises using the transactional approach, the model approach, or the stock exchange approach.

b) Three basic forms of valuation proposed by [29], who says that it is good to use different valuation methods according to what the investor is most interested in or to combine methods from all three areas in order to achieve the widest possible view of the company.

The areas and methods contained in them are as follows:

- Valuation based on revenue analysis

- a. Discounted cash flow method (DCF)
- b. Capitalized net income method
- c. Combined (corrected) yield methods
- d. Economic value added method

- Valuation based on market analysis

- a. Valuation based on market capitalization
- b. Valuation based on comparable companies
- c. Valuation based on data on listed companies
- d. Valuation based on comparable transactions
- e. Valuation based on industry multipliers

- Valuation based on asset analysis

- a. Determining the value of equity on the principle of historical prices
- b. Substantive value on the principle of reproduction prices
- c. Substantial value based on the principle of cost savings
- d. Liquidation value
- e. Property valuation on the principle of market values

In the current economic environment, the valuation of companies under the influence of the pandemic must take into account certain facts that did not exist in the period before the COVID pandemic.

Those factors are:

The date of valuation. When valuing a company, the time of the coronavirus outbreak in Slovakia is crucial. Experts agree that very little was known about COVID-19 by the end of 2019, and we believe that the impact of the pandemic on the value of companies in Slovakia was evidenced by reports that began in January 2020 and the first cases of COVID in Slovakia in early March 2020.

Subsequent events. The valuator must take into account the following events that arose from the outbreak of the pandemic. These are, for example, quarantine measures, the cessation of the operation of large enterprises (eg car manufacturers, which are the driving force of the Slovak economy), restrictions of the international and domestic market, that significantly affect the current development of foreign and domestic production and transport.

Recommended valuation method. Because COVID caused economic disruptions, “the method of choice” should be an income method - Discounted cash flow method (DCF). DCF analyzes the future results of the company until the company is not affected by COVID, ie until the end of the pandemic. Some experts recommend two-to-three-year DCF models; others prefer to use a longer time frame.

Cash flow. Valuators look at cash flow to see if enough money is being circulating in and out of the company to keep the company running smoothly. The role of the valuator is to predict the time horizon within which the company will be able to operate under uncertain conditions caused by a pandemic.

5 Conclusion

The COVID-19 pandemic has affected all aspects of business worldwide, intervening in customer demand, supply chain, commodity price shocks, and macroeconomic policies. Although a pandemic presents a new challenge in the field of business valuation, valuers can find a solution to the new challenges in the basic principles of valuation. The article provides a literary review of the effects of coronavirus pandemic on financial markets, insights on the Impacts of a pandemic on the Slovak economy, and ideas for applicable methods of valuation of companies in Slovakia.

The valuation of a company varies significantly at different points in time, especially if there have occurred significant changes in the economic, industrial, and business factors.

Due to the ubiquitous influence of the covid-19 pandemic, on the economic, industrial, and business factors that potentially can impact company value; it must be emphasized that each case must be assessed individually, the choice of different valuation dates (before, during, or after a pandemic) can have a significant effect on firm value.

To determine whether the impact of a pandemic at the valuation date was known, it is necessary to understand the timeline of the pandemic in both the global and geographical regions of the valuated company.

If we take under consideration valuation date in the first months of 2020, a period when the uncertainty of a pandemic and government action has changed rapidly: increased attention should be paid to determining what was known or expected on a particular date. In addition, each industry participant has faced different circumstances, which should be assessed on a case-by-case basis, and would add an additional layer of complexity of valuation.

Although more difficult to apply, the basic principles of firm valuation during the COVID pandemics are generally the same. A valuator should always be aware of the context of valuation; as far as possible, they should carry out independent analyzes and research into relevant factors for the case. The need for these practices has not changed in the current circumstances, as these have always been essential elements of valuation.

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The digital disruption of ubiquitous economic theories

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Abstract. Digitalisation demands new economic theories because the old laws are losing their validity. They were established to describe the business interrelationships in an analogue world. Now digital business models are breaking the boundaries and taking learned knowledge ad absurdum. New economic theories are emerging from the literature to explain how digitalisation works. The author finds that the new assumptions conflict with some ubiquitous economic theories. The inconsistencies were collected, reviewed, and evaluated. It turns out that at least five doctrines are no longer applicable in the digital world, as their parameters shift elementarily. Using a contrasting example from the music industry, the results were examined and confirmed by way of example. The result is that certain economic theories - from Porter to Pareto - no longer apply in the digital world. The rules must be rewritten so that order can emerge again from the growing chaos.

Keywords: digitalisation, digital goods, digital business model, disruption

JEL classification: O33, M21, M15

1 Introduction

Digitalisation is referred to as the fourth industrial revolution¹. It is changing our lives, our jobs and society. Digitalisation is the result of the convergence of information and communication technology². Information is systematically collected in digital formats, can be stored, processed, and exchanged via the internet to any extent³. Digital convergence⁴ allows companies to move their offerings to the cloud and develop platform-oriented business models. The four internet giants Google, Amazon,

¹ Schwab (2016)

² Stähler (2002)

³ Bauriedel (2020a)

⁴ Covell (2000)

Facebook, and Apple top the list of the most valuable companies⁵. But they play by different rules and are shaking up the traditional order.

The digital good⁶ and its associated business models are fuelling the disruption of economic theories widely used until today. An example why those ubiquitous economic theories are not anymore applicable: In the past, music was stored on physical sound carriers, which were produced in a pressing plant, distributed via a dealer network and sold in stationary music shops. The music shop was subject to the restrictions of the stationary trade: low range, limited opening hours, limited product variety and low storage capacity. The manual work for handling the goods, advising the customers, collecting the money and other administrative tasks set further limits to the business model. Today, music is a digital good and is offered for download or consumed directly in a stream. A music platform like iTunes needs no physical goods, no factory, no shops, and no operational staff. It eliminates all manual and intellectual activities in manufacturing, logistics, storage, consulting, and payment. In addition, digital business models can be used at any time, are accessible from anywhere and are particularly easy to use⁷. iTunes has revolutionised the music business. Digitalisation was not used to improve the stationary music business, but to create a completely new, innovative business model. The basic needs of the customer are satisfied in a new way, and the new business model is faster, better, and easier. First and foremost, customers save time and money, experience a huge choice as well as one hundred percent availability. Ultimately, they get a product that neither wears out nor gets lost.

At first glance, iTunes is an app for the smartphone. Only a deeper look behind the scenes shows that digitalisation brings multi-layered and complex changes. The disruption of the music sector is one example. Many other industries such as retail, travel agencies, car rental companies, banks, etc. are also affected.

2 Theoretical background

The economic theories mentioned in this article are part of the recognised basic knowledge in economics. For a better understanding, the basics are briefly described. Furthermore, the terms digital good, digital business model and disruption are named.

2.1 Ubiquitous economic

The term ubiquitous economic theories is deliberately chosen because the economic theories mentioned here are anchored in microeconomics on the level of business management. They really "occur everywhere". They are on the syllabus of every business university, they influence our entrepreneurial actions and have become social consensus. Every manager is shaped by these doctrines and must first discard their own limited way of thinking to be able to tap the potential of digitalisation for themselves.

⁵ Focus Online Group GmbH (2020)

⁶ Clement, Schreiber and Bossauer (2019)

⁷ Bauriedel (2017)

For the digital era it is necessary to rethink the corporate strategy, the business model, the processes and the IT infrastructure.⁸

2.2 Productivity

According to Hal Varian, master of microeconomics, productivity results from the three factors labour, capital, and resources⁹. It is the ratio that determines the effort (labour hours, monetary units, and raw materials) to produce a certain product.

2.3 Porter's theories

Michael E. Porter is one of the most influential theorists in strategic management. He follows the assumption that companies should choose from three generic competitive strategies (segmentation, differentiation, and cost leadership)¹⁰ to take a distinct, strategic position in the market.

2.4 Blue Ocean Strategy

W. Chan Kim outlines his idea of a Blue Ocean¹¹. He challenges entrepreneurs to ignore existing competition, think outside the box and develop new markets. The new business idea should offer the customer greater benefits and at the same time reduce costs. He describes that companies focus too much on bloody competition: "The dominant focus of strategy work over the past thirty years has been on competition-based red ocean strategies."¹² He contrasts this with his theory of a redefined market with changed competitive factors, the blue ocean. "Blue oceans, in contrast, are defined by untapped market space, demand creation, and the opportunity for highly profitable growth."¹³

2.5 Scarcity

The insatiability axiom¹⁴ states that people have an infinite need. Since there is a cost to providing goods, the quantity supplied is always less than the quantity demanded. There is an eternal scarcity of goods.

⁸ Bauriedel (2020c)

⁹ Varian (2016)

¹⁰ Porter (1985)

¹¹ Kim and Mauborgne (2015)

¹² Kim and Mauborgne (2015, p. 8)

¹³ Kim and Mauborgne (2015, p. 4)

¹⁴ Woll (2003, p. 50)

2.6 Pareto principle

The Pareto effect¹⁵ describes that with 20 percent of the effort 80 percent of the result is achieved.

2.7 Digital goods

Digital goods are intangible products (images, audio, video, information) or virtual services (games, software, cloud computing). In contrast to physical goods, they have special characteristics: easy reproduction, simple processing, simple distribution, multiple ownership and no wear and tear or loss¹⁶. The exchange of digital goods via networks makes them independent of time and space¹⁷. The mass distribution of digital goods requires the standardisation of file formats (e.g., html, pdf or jpeg).¹⁸

2.8 Digital business models

Christian Hoffmeister sees business models as a development process for standardised trade. "The permanent repetition of processes turns a trial-and-error procedure into a fixed procedure that serves as a binding instruction for all employees."¹⁹ Business models are evolving from individual to dominant to unstable. Traditional business models - in his view - are becoming increasingly unstable because "the internet creates new needs through new service models. At the same time, known needs are being satisfied differently than before. This leads to changes in established industries as well through new providers with new business models."²⁰

Patrick Stähler examined digital business models at an early stage. He explains, "By means of business models, information management attempts to map the reality of a company with its processes, tasks and communication relationships onto an IT system in order to support the company in its tasks."²¹ He names three components of a business model: the value proposition, the architecture of value creation and the revenue model.²² In addition, he points out, "Business models on the internet are only new if they also use the possibilities of new media, i.e. ubiquity, the activity of the information carrier, networking and multimedia, although it is not crucial to use all features at the same time."²³

Alexander Osterwalder has taken Stähler's concept of a business model and developed it further. His definition is: "A business model describes the basic principle

¹⁵ Koch and Mader (2015)

¹⁶ Clement, Schreiber and Bossauer (2019, p. 36)

¹⁷ Stähler (2002, p. 112–113)

¹⁸ Covell (2000)

¹⁹ Hoffmeister (2013, p. 6)

²⁰ Hoffmeister (2013, p. 13)

²¹ Stähler (2002, p. 38)

²² Stähler (2002, p. 42)

²³ Stähler (2002, p. 181)

by which an organisation creates, conveys and captures value."²⁴ In contrast to a traditional business model, the digital business model focuses on the possibilities of digital technologies. Digital business models satisfy basic needs in a new form²⁵ and they are better in the performance characteristics that are important for the customer.²⁶

2.9 Disruption

Disruption is a young term with a longer history. As early as 1942, Joseph Alois Schumpeter published his remarks on the renewal of markets, which is initiated by entrepreneurs. He describes disruption as follows: An idea is good until a new, better one replaces it.²⁷ Later, Richard N. Foster²⁸ found that there is a dependency between the effort for improvements of a technology and its performance. According to his S-curve model, new technologies show only a low performance at the beginning, which can be improved slightly. During development, the performance increases and helps the technology to achieve a breakthrough. In the third phase of the S-curve, a further increase in performance can only be achieved at great expense. Clayton Christensen²⁹ took up Foster's idea and expanded his model into a Multiple S-curve Model. In his doctoral thesis at Harvard University, he examined waves of technological innovations among manufacturers of storage media. He found that disruptive innovations initially perform worse. After a certain point, the new technology overtakes its predecessor - in rapid steps - and becomes the leading technology. Clayton Christensen created the term disruptive innovation and studied why companies fail when new technologies change the market. According to his studies, there are two criteria that constitute a disruptive innovation. First, the new technology has new performance characteristics. Second, the performance characteristics that the customer values can be improved quickly so that the new technology takes over the established market. Rebecca M. Henderson³⁰ created the term Architectural Innovation. She does not look at a product as a whole but divides it into different components and thus examines the structure of a product. Henderson distinguishes between four directions of innovation: incremental, modular, and architectural innovation, as well as radical rethinking. While Christensen and Henderson placed a clear focus on technical innovation and product design, the horizon must be broadened for the digital disruption of business models. It encompasses the entire customer life cycle (initiation, purchase, delivery, use, service) and not only the disruptive innovation of the product.

²⁴ Osterwalder and Pigneur (2011, p. 6)

²⁵ Stähler (2002)

²⁶ Christensen (2016)

²⁷ Schumpeter (1942)

²⁸ Foster (1986)

²⁹ Christensen (2016)

³⁰ Henderson and Clark (1990)

3 Research Design

This research shows that well-known economic theories conflict with the digital world. It is delicate to challenge these established doctrines lightly and the explanations will cause incomprehension as well as resistance, but it is necessary.

3.1 Triggers

The literature presents a fragmented picture of digitisation. Each author describes digitalisation from their own point of view, which leads to a one-sided and isolated view. The strategy consultants explain the new business models, the microeconomists have recognised that transaction costs are falling, and the technology providers talk exclusively about web, app and cloud.

The study of the literature also shows that new theories are emerging to explain the digital world. These assumptions have two weaknesses. First, they each illuminate only one aspect of digitalisation and do not show the whole picture. Second, the authors disrupt the ubiquitous economic theories, even if they may not be aware of it.

3.2 Procedure

The procedure for this argumentative study is based on assertion, justification, and examples. Inconsistencies were found and initially collected during an intensive literature review. Gradually, the insight emerged that all disagreements are restrictions of a physical world.

The examination of the discrepancies was done by directly comparing a physical good, which is offered in stationary distribution, and a comparable digital good, which is distributed via a digital platform. For a complete elimination of physical limits, the author specifically replaced variables of known economic formulas with zero or infinity. This resulted in recognised formulas no longer making sense in the digital world. In the following, all collected inconsistencies were examined to see if they disrupted known economic theories. A total of five established models were identified that no longer work in the digital world or require revision. These could be substantiated with prominent examples.

3.3 Framework conditions

Digitisation has no clear contours, so a research design is chosen that shows as much contrast as possible between the analogue and digital worlds. The following framework conditions and simplifications reinforce the contrast.

Digital goods and business models

This study focuses on digital goods and business models, which are contrasted with their respective analogue counterparts. Platforms that sell digital goods were specifically selected for comparison with stationary trade. The music platform iTunes is an ideal example.

Infinite transaction volume

Another assumption is that platforms have infinite capacity. They can be scaled arbitrarily in terms of processors, memory, and bandwidth. Transaction volumes are now so high that platforms are dubbed hyperscalers³¹. Facebook, for example, has more than 2.85 billion active visitors³² and the online retailer Amazon offers 226 million products³³ in Germany.

Zero transaction costs

Transaction costs are assumed to be zero. The construction and operation of a platform certainly cause costs. Therefore, the second assumption is that the transaction volume grows exponentially. With the high volume, the marginal costs decrease drastically³⁴. The assumption of zero is possible because transaction costs are high in the analogue world and marginal in the digital world. Processing a loan application, for example, takes several hours in a bank, while the platform only needs a fraction of a second. The enormous difference in transaction costs - analogue vs. digital - allows an idealised value of zero.

4 Key Results

Some economic theories are changing as the limitations of an analogue world are broken down. This is triggered by digital goods and the associated business models. Productivity increases as the two factors of labour and resources approach zero. The "blue ocean" strategy aims at a new market with higher value and lower costs. Digital goods create an abundance and vie for customers' attention. The new frontier of the retail shelf is the market. Revenue models are reshaping significantly.

4.1 Productivity

The digital business model requires no manual labour and the digital good is an inexhaustible resource that can be copied or recalculated at will. The example of music distribution shows that manual labour is eliminated, less capital is required, and music is simply copied. Even the remaining component of capital is reduced, since the development of a platform is cheaper than the construction of a production plant including an international distribution network. The calculation of productivity includes two factors (labour and resources) with a value of zero. Its calculation based on capital alone is therefore meaningless. Without the physical capacity constraints³⁵, there are extreme productivity gains³⁶, limited only by customer demand.

³¹ Manyika und Chui (2014)

³² Statista GmbH (2021)

³³ Brandt (2017)

³⁴ Clement, Schreiber and Bossauer (2019, p. 67–69)

³⁵ Stähler (2002)

³⁶ Bauriedel (2020b)

4.2 Porter

W. Chan Kim³⁷ opposes Porter's views with his "Blue Ocean Strategy". He calls on companies not to orient themselves to the competition, but to focus on the core elements from the customer's point of view. According to his theory, markets are formed around the fulfilment of customer requirements. A "blue ocean" is created when it is possible to convince customers and non-customers by offering better benefits as well as at a lower price. Digital business models follow exactly this call. They provide services in a new form, improve their important features from the customer's point of view and drastically reduce transaction costs. The centre of digital business models is the customer purpose³⁸ or value proposition³⁹, the promise to the customer. Apple's success illustrates how digital business models are disrupting the old world. Porter's protectionism could not protect the brick-and-mortar music store because, as Schumpeter describes it, the new idea has relentlessly taken hold.

4.3 Abundance

Digital goods are neither scarce nor free. Free goods are usually taken from nature, whereas digital goods are generated the moment the need arises. This creates an abundance since any need is met immediately without effort. A simple but obvious example is the digital photo. In the past, the holiday photo was a scarce commodity because a 35mm film held 36 shots. Each shot was meticulously planned, as films were scarce and development costly. Today, every smartphone has a camera built in. Photos are now digital goods that can be stored, presented, and shared for free. The cost of a photo approaches zero and availability tends towards infinity. This leads to another phenomenon: waste⁴⁰.

4.4 Pareto

Every stationary shop has a limited range of products. It is necessary to limit the product variety in advance according to the Pareto principle because the sales area is limited. For economic reasons, it is necessary to fill the sales shelves with popular offers to achieve the profit optimum. Retailers concentrate on the section of the market that promises them the greatest profit. In contrast, the iTunes music platform has created a perfect marketplace⁴¹. With over 70 million songs⁴², it offers all the commercially published music in the world. The platform is an infinite, digital sales shelf without physical boundaries. It does not follow the Pareto principle, but takes advantage of the long tail.

³⁷ Kim and Mauborgne (2015)

³⁸ Ismail, Malone and van Geest (2017)

³⁹ Osterwalder, Pigneur, Bernarda and Smith (2015)

⁴⁰ Diamandis and Kotler (2012)

⁴¹ Jevons (1871)

⁴² Apple Inc. (2021)

Chris Anderson⁴³ has evaluated the downloads of music platforms and found that the long tail is economically interesting. His research in the music industry shows 98 percent of the platform offer is continuously in demand. Customers love the variety and consume niche offers that have been sorted out by the stationary trade. In the digital world, the long tail is an additional offer that produces significant sales without further effort. Anderson then also examined sales and profits. According to his calculations, an online platform with a 10-fold larger offering compared to a brick-and-mortar shop generates 25 percent of its sales and 33 percent of its profits through the long tail. Compared to Anderson's calculation, the leverage of the large internet platforms is many times greater. The profitability of electronic platforms thus increases with their product diversity.⁴⁴

Platforms have no capacity limits, they scale arbitrarily and adapt to the available supply. It makes absolutely no difference to the platforms which and how many digital goods they host. It is even an advantage to fill them to the limits of the market, because the already low marginal costs fall even further via unit cost degression⁴⁵. As Patrick Stähler, a thought leader on digital business models, points out, "The optimal output is the market."⁴⁶ Pareto fails because the expenditure for an additional product offering approaches zero. It is completely misguided to emphasise the 20 per cent or neglect the 80 per cent when the 100 per cent represents no additional effort.

4.5 "Free"

There is a saying that goes, "Nothing is free." But digital goods are offered free of charge. The reason is the low transaction costs. This is because platforms do not require manual labour and do not need physical resources. On the other hand, the platform requires high utilisation, and a lack of transactions means stagnation. The third important reason is customer attention, as a free offer seduces and lowers switching barriers. Brick-and-mortar retailers also advertise free offers, but their high expenses limit their ability to push them through.

Chris Anderson⁴⁷ has examined the free offer, also called "free", and described the various revenue models behind it. These are diverse and range from a free basic offer to a commissioned business model to advertising-based sponsoring. According to his research, the background is that the revenue model has fundamentally changed, or free resources are given away as a loss leader. "Free" or a price of zero, does not fit into our traditional basic understanding of business administration. Turnover is calculated by multiplying the products sold by the price. With "Free", however, the price and thus the turnover is zero. The idea of a mixed calculation arises, but the ratio of fee-based to free products is not 90/10, but 10/90. Another objection is that indirect revenues (e.g., commissions, advertising, or donations) make up the actual turnover. This is opposed by a complete decoupling of the product from the revenue model. There is no

⁴³ Anderson (2008)

⁴⁴ Stähler (2002, p. 197)

⁴⁵ Clement, Schreiber and Bossauer (2019, p. 67–69)

⁴⁶ Stähler (2002, p. 197)

⁴⁷ Anderson, Schöbitz and Vode (2009)

compulsion whatsoever for the customer to buy. Typical examples are the search engine Google, the game "Angry Birds" or the encyclopaedia Wikipedia. It is a serious change in revenue models, because until now it was not possible to give everything away and still generate revenue.

5 Conclusions and Recommendations

Technological progress is inevitable. It begins with Peter Schumpeter, who describes the constant renewal of the economy⁴⁸, goes on to Nikolai Kondratjew⁴⁹, who describes economic development as cycles and does not really end with Klaus Schwab, who proclaims the fourth industrial revolution⁵⁰. Ultimately, it is Peter Glaser who aptly describes digitalisation: "Everything that can be digitalised will be digitalised. Everything."⁵¹

The elimination of physical boundaries demands a new way of thinking, but the digitalisation of goods and business models has only just begun. The music platform iTunes shows how fast and relentlessly digital disruption can proceed. Other industries - travel, banking, retail, etc. - will follow and significantly change our inner cities.

At the same time, this contribution creates great resistance. It arises from our analogue thinking, because it is not possible to grasp the digital world with analogue laws. A new perspective is needed to understand and accept the new laws for oneself. One way to solve that dilemma is that science starts to incorporate the new laws into its teachings.

5.1 Everything is going digital

Digital convergence is only just beginning. Books, music, pictures, and videos are already digital goods, but now the big block of information is following. Little by little, digital goods are taking over our lives, forming ever more complex structures.

The digital goods network with each other and form themselves into multi-layered blocks of information. Every online shop needs highly precise digital product information. These are composed of texts, photos, videos, and reviews and now form an information block. Digital convergence now also covers advice-intensive products and services such as real estate, travel, cars and securities. In principle, the knowledge of the salesperson is slowly but surely being transferred into digital information, making the salesperson superfluous.

Facebook and Google are data collectors that gather all available information and use it to form targeted user profiles. These profiles reflect, for example, a person's taste in music, but also their political opinion or sexual preference. The person does not have to have explicitly expressed this preference or even be aware of it. Complex algorithms

⁴⁸ Schumpeter (1942)

⁴⁹ Nefiodow and Nefiodow (2014)

⁵⁰ Schwab (2016)

⁵¹ Glaser (2018)

generate multi-faceted profiles with a high hit probability from a small amount of information. User profiles are digital goods that are used for advertising.

Our money is also a digital good. Its entire cycle, account balances and deposits are electronic bookings. Internet start-ups rely exclusively on cashless payments because they don't want cash registers, change or safes. They have realised that physical money is no longer needed. Unfortunately, cash is still a relic from the Middle Ages. Clinging to notes and coins paralyses our economy and delays the step into the next era.

With the proliferation of digital goods, the upheaval of economic theories is also beginning. Our analogue world may continue to follow the old rules, but digital business models are taking over the world. Salim Ismail describes this particularly aptly in his book *Exponential Organisation*: "An information-based environment creates fundamental disruptive opportunities."⁵²

5.2 Rejection

The author has over 30 years of experience in strategy, business, technology, and change. As a management consultant, he has gained deep knowledge of the organisational structure of companies and their IT infrastructure in numerous projects. He has been researching and publishing on digital strategies and their implementation for five years.⁵³

Despite the success of digitalisation is proven by big tech companies. The author observes a lot of rejection after an initial interest when it comes to the rethinking of established theories by decision-makers, managers, project leaders and even scientists. Even the Readers of this paper must first process these huge changes in economic theories. Accepting the new facts is not easy. This has been shown in numerous discussions and workshops with interested parties. Rather, it is necessary to present the arguments several times, to show the change with examples and to explain it again and again. The interest is great, but unfortunately so is the resistance. If entrepreneurs use digital freedom for themselves, disruptive opportunities open. The failure of economic theories creates unease and chaos. Which rules can the entrepreneur still follow? How can decisions be tested? Which strategy is the right one? It is a time of upheaval, looking for new answers and a new order. Theories for the digital world need to be developed and anchored in textbooks, universities, and companies. But it is not only about the institutions that house these theories, but about the people - graduates, professors, executives, strategy consultants and digital experts - who should transport them.

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Internet of Things and Its Use in Business Entities of the World

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Abstract. The Internet of Things digitally transforms business entities, bringing them many benefits and the opportunity to become a digital business. The main goal of the scientific article is to theoretically define the digital technology Internet of Things and to map the current state of use of the Internet of Things. Internet of Things is industry 4.0 digital technology, which is a network of interconnected devices over a wireless connection, which are made up of technological and other components used to interconnect elements in an enterprise environment and provide various services. The scientific article focuses on the theoretical definition of the term Internet of Things, its characteristics, ecosystem, technology and Technology Stack Internet of Things. The results of the work and discussion include: mapping the application and use of the Internet of Things in various sectors, then in selected business entities, evaluating the use and defining your own definition of the Internet of Things. The examined business entities include: ABB, Airbus, Amazon, Boeing, ESI, Bosch, Caterpillar, Cisco, Intel, SAP, Siemens, Shell, Tesla.

Keywords: Digital technologies, Internet of Things, Industry 4.0, Business

JEL classification: *M15, M20*

1 Introduction

The COVID-19 pandemic is currently having a global impact on business and the economy by changing their way. Responses to COVID-19 have accelerated the adoption of digitalization, digital technologies in companies around the world, and

today digital transformation is one of the fundamental challenges for businesses. Digital technologies, which are the driving forces and the most important elements of Industry 4.0, are essential for the digitalization and digital transformation of businesses. Among the key digital technologies of Industry 4.0, in addition to Artificial Intelligence, Big Data Analytics, Cloud Computing, the Internet of Things is also included. The digital transformation based on the Internet of Things is applied to physical objects whose central point is data. The current business environment creates incentives for the direct implementation of elements of Industry 4.0 - digital technologies into business processes and business models in order to maintain competitiveness, operational efficiency, profitability and especially innovation.

2 Literature review

Internet of Things (IoT) was introduced by Kevin Ashton in his presentation in 1999 and refers to a network of devices containing various electronics, sensors and other elements that allow these devices to communicate and exchange data, with each device clearly identifiable in the network. Camacho-Cogollo et al. (2020) state that IoT is a major front-end of intelligent technologies and is considered a new Internet revolution. The elements that supported the emergence and existence of the Internet of Things are: the availability of broadband wireless Internet and the emergence of a necessary, ubiquitous and distributed computing environment across the planet; miniaturized sensors built into everyday objects, home security and health monitoring systems, data collection and connection and communication from sensors built into other products or people, and the last element are Collaborative Robots (Cobots) using artificial intelligence and machine learning (Özdemir & Hekim, 2018).

The basis of the philosophy of Internet of Things according to Dhonge (2016) is a network of intelligent physical objects or things that are wirelessly interconnected, in which it is built: electronics, software, sensors and Internet connection enabling the collection and exchange of data. According to Madakam, Ramaswamy and Tripathi (2015), the Internet of Things is an open and comprehensive network of intelligent objects that are able to automatically organize, share information, data and resources, respond and act in the event of situations and changes in the environment. Nelson (2016) defines the Internet of Things (IoT) as intelligent objects that monitor, record, and compute through nested and interconnected presentations. IoT is an Internet extension that integrates mobile networks, the Internet, social networks and smart things to provide better services or applications to users (Li, 2017). Majumdar (2019) states that the Internet of Things is a network of interconnected objects ("things") for collecting and exchanging data with each other through built-in electronics, software and sensors across the Internet. According to Gillis (2020) Internet of Things is a system of interconnected computing devices, mechanical and digital machines, objects, animals or humans that are provided with unique identifiers (UIDs) and the ability to transmit data over networks without requiring interconnected human interaction. -to-human or human-to-computer. IoT refers to the Internet interconnection of several nodes integrated with sensors, actuators, electronic equipment and network connections

to facilitate the interconnection and easy transmission of data in a real-time environment (Mishra et al., 2020). Gartner (2021) defines the Internet of Things as a network of physical objects that contain built-in technology for communicating and perceiving or interacting with their internal states or external environment. Liu (2020) states that the Internet of Things is a set of sensing, communication and computing technologies for connecting physical objects such as wearable devices, vehicles and buildings, and a large amount of data is generated from interconnected "things". Data analysis plays a central role in the automated and intelligent decision-making process for managing and optimizing IoT systems. Oracle (2021) describes the Internet of Things as a network of physical objects - "things" that are equipped with sensors, software and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet. The Internet of Things refers to working on the Internet for various types of physical devices equipped with transducers, including sensors, detectors, actuators, electronic components, and links to devices and websites, to maintain association and stress-free data exchange in real time (Sharma , Bhargava & Singhal, 2020).

2.1 Internet of Things ecosystem and characteristics

The Internet of Things consists of real-world things and sensors connected to or combined with these things and connected to them via a wired and wireless network.

Characteristics defining Internet of Things by I-Scoop (2021) are:

1. *Connectivity* - There must be connections at different levels between all the devices used in the IoT concept, hardware, sensors, electronics and control systems.
2. *Things* - Anything that can be tagged or attached is for connection. Devices may include sensors or sensing materials may be attached to the devices and items.
3. *Data* - They are an essential part of the IoT, the first step towards action and intelligence.
4. *Communication* - Devices connect to be able to communicate and then analyze the data. Communication can take place over short distances or very long distances up to very long distances. Examples are Wi-Fi, LPWA network technologies such as LoRa or NB-IoT.
5. *Intelligence* - Aspects of intelligence, such as scanning capabilities in IoT devices and intelligence obtained from big data and AI analysis.
6. *Action* - The consequence of intelligence - it can be manual action, action based on discussions about intelligent decisions in companies and automation, often the most important part.
7. *Ecosystem* - The place of the Internet of Things and its integration in terms of other technologies, communities, goals and the image in which IoT is used.

The Ecosystem IoT consists of intelligent web-connected devices that use embedded systems, such as processors, sensors, and communications hardware, to collect, send, and act on data they obtain from their environments. IoT devices share data from

sensors that they collect by connecting to an IoT gateway or other peripheral device where data is sent to the cloud for analysis or analysis locally (Techtarget, 2020). IoT sensors can use different types of connections such as RFID, Wi-Fi, Bluetooth and ZigBee, and also allow broadband connectivity using many technologies such as GSM, GPRS, 3G and LTE. IoT-enabled things will share information about the state of things and the environment with people, software systems and other devices (Zeinab & Elmustafa, 2017).

2.2 Internet of Things technology stack

Farahani et al. (2018) state that IoT has evolved from Radio Frequency Identification and Wireless Sensors Networks technologies to more advanced integration with Internet services, cloud computing, cyber-physical systems, and connections between software and hardware devices. Technologies Internet of Things according to Madakam, Ramaswamy and Tripathi (2015) are: Radio Frequency Identification (RFID), Internet Protocol (IP), Electronic Product Code (EPC), Barcode, Wireless Fidelity (Wi-Fi), Bluetooth, ZigBee, Near Field Communication (NFC), Actuators, Wireless Sensor Networks (WSN) and Artificial Intelligence (AI).

Sharma, Bhargava & Singhal (2020) state that the IoT technology stack is a classification of many technologies used in IoT categorized into broad layers, and the number of layers integral to the IoT ecosystem may increase over time. According to the authors Sharma, Bhargava and Shinghal (2020), there are three basic layers on which it works and these are:

1. **IoT device layer** is the layer where an IoT ecosystem begins, and its accuracy has a huge significance in the performance of any smart product whose ecosystem depends on it. It interacts with the physical environment through the “things” in the IoT. The device in this layer should contain at least the following IoT-enabled things:
 1. *transducers, sensors, or/and actuators and*
 2. *device connectivity*—transmitters, receivers, and device-operating software.
2. **IoT gateway layer** is the pathway or bridge through which the transmitted data flow from the layer of “things” to the layer of operations. Edge computing/fog computing is the technology powering digital connectivity with abilities like high-grade processing and smart analytics. It is no ordinary bridge however, rather it is a smart and intelligent gateway housing technologies to aggregate connectivity for things to communicate while preprocessing their data, translating protocols, and ensuring network security.;
3. **IoT platform layer** could be called the control center of a smart system, though it obviously does much more than just that. This is where everything actually connects to create their intelligence! With cloud storage, smart analytics of big data, machine learning, high-speed messaging, and central processing this layer integrates a plethora of diverse technologies, clouds, software services, and APIs to ensure IoT interoperability device virtualization and real-time responses. It is the middleware between input and output in the IoT ecosystem..

3 Research objectives and methodology

The main goal of the scientific article is to theoretically define the digital technology Internet of Things and to map the current state of use of the Internet of Things.

The sources of data for the processing of scientific articles were domestic and foreign professional literature in the form of: books, scientific articles and studies, surveys of technological and statistical companies, press releases of business entities, etc.

In the scientific article, we used the analysis to analyze the current state of the issues discussed in foreign and domestic literature; we used the comparison when comparing the definitions of IoT and also when comparing the ways of using IoT in specific companies and we used induction in the formulation of the conclusion.

The subject of research is digital technology Industry 4.0 Internet of Things, where we theoretically defined it in the literature review, in the results we mapped the current state of IoT use in business entities through studies and examples of applications in selected companies. The object of the investigation was selected business entities according to the IoTONE ranking, namely: ABB, Airbus, Amazon, Boeing, ESI, Bosch, Caterpillar, Cisco, Intel, SAP, Siemens, Shell and Tesla.

4 Results

In the results of the scientific article, we decided to map and examine statistical analyzes related to the Internet of Things and to examine the specific use of IoT in selected business entities.

4.1 Statistical data about Internet of Things

According to Statista (2021), the total Internet of Things (IoT) market reached approximately US \$ 388 billion in 2019 and is set to increase to more than one trillion US dollars in 2030. The market is dominated by the consumer sector and is expected to generate \$ 476 billion in sales by 2030. In the following Fig. 1 shows Statista's (2021) expenditures on the Internet of Things of various industries by vertical around the world in 2015 and their forecast for 2020. As we can see, the most expenditures in 2015 - 10 billion of US dollars had industries: Discrete manufacturing, Transportation and logistics and the least expenses were incurred by the Insurance industry (2 billion of US dollars). The forecast for 2020 was favorable in all sectors and each sector expected an increase. Expected average spending in 2020 increased by 303%, representing an average increase of 16.82 billion of U. S. dollars to 22.36 billion of U. S. dollars. The largest percentage increase of 500% was expected by the Retail sector (from 2 billion of US dollars to 12 billion of US dollars), an increase of 471% was expected by the

Utilities sector (40 billion US dollars, which represented an increase of 33 billion of US dollars) and further B2C by 400% from 5 billions of US dollars to 25% dollars. The Insurance industry expected an increase in spending of only 150% compared to other industries and represented the smallest spending in 2020. Total expenditures from the 2017 forecast for 2020 were to be 246 billion of US dollars, the 2020 forecast from the Statist states that expenditures on Internet of Things technology are expected to be at the level of 749 billion of US dollars, which represented an increase of 204 %.

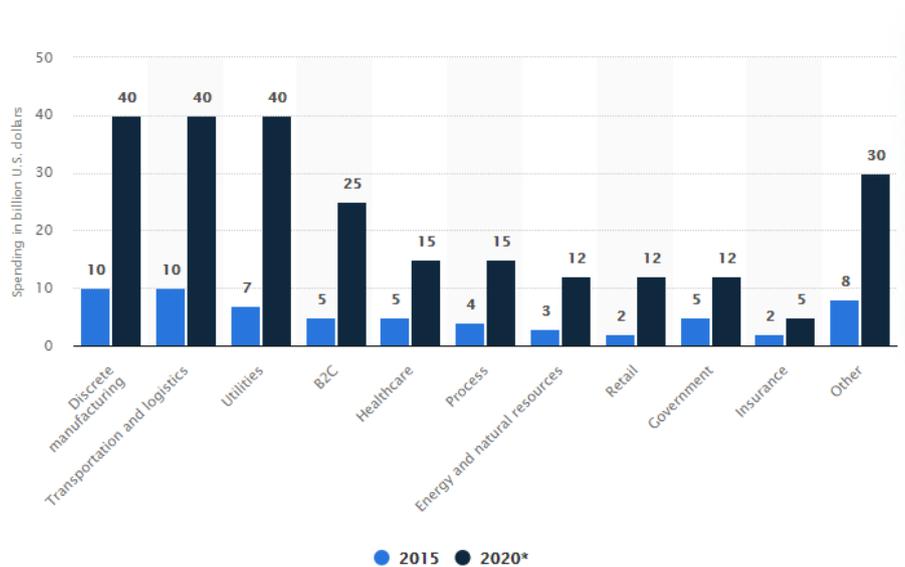


Fig. 1. Spending on Internet of Things Worldwide by Vertical in 2015 and 2020 (in billions of U. S. dollars)

In 2019, there were 7.74 billion of Internet of Things connected devices worldwide, and Statista (2020) further states that the number of Internet of Things devices should be at 8.74 billion in 2020 and triple by 2030. to the level of 25.4 billion of Internet of Things devices. Furthermore, according to forecasts of Internet of Things devices, 40% will be used in businesses. In 2019, there were 7.74 billion of Internet of Things connected devices worldwide, and Statista (2020) further states that the number of Internet of Things devices should be at 8.74 billion in 2020 and triple by 2030. to the level of 25.4 billion of Internet of Things devices. Furthermore, according to forecasts of Internet of Things devices, 40% will be used in businesses.

IoT Analytics (2020) examined Internet of Things applications in selected businesses in various industries. As can be seen in FIG. 2, out of the total number of 1414 IoT projects, the most projects were: in the Manufacturing / Industrial sector - 22% (approx. 311 IoT projects), followed by 15% in the Transportation / Mobile sector (approx. 212 IoT projects), in the Energy sector - 14% (about 197 IoT projects). IoT Analytics (2020) examined Internet of Things applications in selected businesses in various industries. As can be seen in FIG. 2, out of the total number of 1414 IoT

projects, the most projects were: in the Manufacturing / Industrial sector - 22% (approx. 311 IoT projects), followed by 15% in the Transportation / Mobile sector (approx. 212 IoT projects), in the Energy sector - 14% (about 197 IoT projects).

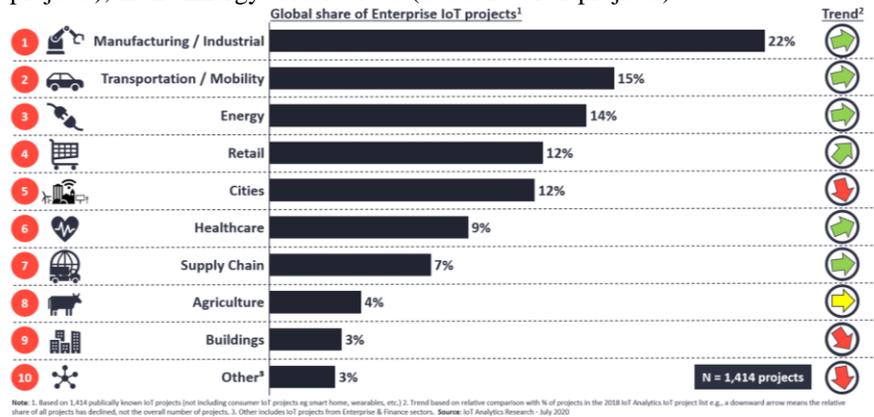


Fig. 2. Top 10 IoT Application areas 2020 by IoT Analytics

Techjury (2021) states that: by 2025, there will be more than 64 billion Internet of Things devices worldwide; the main driver of revenue for 54% of IoT's enterprise projects is cost savings; in the surveyed companies using IoT, corporate investment accounted for more than 50% of total IoT expenditure in 2020; 97% of the organizations surveyed believe that creating value from IoT data is challenging; IoT in the banking and financial services market is expected to grow to \$ 2.03 billion by 2023; 58% of manufacturers say that IoT is required for the digital transformation of industrial plants, and more than 80% of executives across industries say that IoT is critical for some or all business sectors.

In 2021, IoTONE compiled a ranking of the best industrial companies in the field of the Internet of Things. The top 15 best companies include: Siemens, PTC, ABB, Intel, Schneider Electric, Honeywell, Huawei, SAP, Advantech, Bosch, Cisco, Amazon Web Service, IBM, Texas Instruments and C3 IoT.

4.2 Use and application of the Internet of Things in selected business entities

ABB is a Swiss-Swedish multinational company providing energy and automation technologies and has adopted the concept of predictive maintenance and uses IoT for: connected systems, Internet assets, ad-hoc mobile devices and simulation and security support. In specific situations, it would be used in interconnected oil and gas extraction, connected renewables, connected vessels, connected mines, connected paper mills and interconnected data centers. (ABB, 2021).

Airbus is a French airplane manufacturer, they said that “One first things the company did was to use RFID in tracking parts, and now they are moving towards IoT devices to track tools in the factory, so engineers know where their key tools are, and also so the tools can be telling them if the torque is correct for implementation, and also

look if products need maintenance. So, they are looking at a whole raft of things to not only improve products but also to reduce cost and improve production capability.” (Airbus, 2021).

Amazon is American multinational conglomerate which focuses on e-commerce, cloud computing, digital streaming, and artificial intelligence. AWS IoT helps customers by providing edged based software including Amazon FreeRTOS and Amazon Greengrass that allows customers to securely connect their assets, gather data and take intelligent actions locally even when the internet connectivity is down. ... Customers only pay for what they use. (Amazon AWS, 2021)

Boeing is the biggest airplane manufacturer in the world. It was found in 1916 in USA Seattle. They have been using Artificial intelligence primarily for piloting the plane. Their subsidiary – Tapestry Solutions Inc. launched Enterprise Sensor Integration (ESI) software platform that is designed to transform supply chain operations and help businesses tap the power of the Internet of Things. Every single component Boeing 787 is attached to a wireless airplane network, providing real-time IoT data on everything from performance to required maintenance. The aircraft can produce more than a third of a terabyte of data per flight and each one makes hundreds if not thousands of flights a year. (Boeing, 2019)

ESI is based on Tapestry’s field-proven technology deployed at 50 Boeing assembly plants. At Boeing, the custom technology is called the Automated Identification Technology – Information Management System (AIT-IMS). In its first year alone, AIT-IMS is said by the parent company to have saved Boeing approximately \$100 million through decreased assembly time, automated asset receipt/payment, enhanced inventory management and improved quality and safety. The software harnesses the power of Big Data, boosting manufacturing efficiency, productivity and profitability. It serves as the foundation for the IoT, where internet-enabled devices are connected, intelligent and interactive. (IoT Now, 2016)

Bosch is a German company that provides solutions for mobility, housing units, industry and services. In the mobility in terms of Internet of Things their focus was in creating sharing services, simplify the search for parking spots, show eBikers where they need to go, and inform customers when they need to recharge their electric car battery. The goal is to make each ride as safe and comfortable as possible, regardless of the mode of transportation. In terms of housing units – they focused on smart home features like house maintenance, gardening or security system that was supported by IoT. In industry, they use IoT features for increasing efficiency and safety in manufacturing. (Bosch, 2021)

Caterpillar is the world’s leading manufacturer of construction and mining equipment, diesel and natural gas engines, industrial gas turbines, and diesel-electric locomotives. Caterpillar has already been using IoT technology to automate its factories and has manufactured a range of heavy-duty equipment complete with IoT sensors. However, while IoT powered equipment is working hard onsite, Caterpillar is also gathering vast quantities of data from the machines. This data is then being put to work to enable predictive maintenance on the equipment. By turning data into actionable insight, Caterpillar can schedule maintenance at the appropriate time, thereby

increasing product uptime, and extending the life cycle significantly. (Fieldserviceasia, 2021).

Cisco is an American computer company that concentrates on multiple hardware and software solutions for businesses. From Industrial switches, towards industrial routers and gateways, Cisco is providing that sort of solution for many industry businesses. They also developed several software solutions that can cover the communication with hardware f.e. iox for edge applications and industrial network director. They developed Cisco Cyber Vision and discovered Cisco Edge intelligence that provide security towards businesses. Main focus was cybersecurity and data Intelligence. (Cisco, 2021)

Intel is also an computer company that focuses on microchips and integrated circuits. They are mostly known for being a company that manufactures computers, mainly processors. They also started to use Artificial intelligence f.e. to save coral reefs, they helped to create automated car factory for Audi and uses artificial intelligence to disinfect hospital surfaces due to today's Covid-19 situation. They also invested into the edge and cloud computing and Intel also provides solutions for smart cities. Like a Cisco, they also provide many hardware and software solutions for existing businesses that can increase business efficiency. (Intel, 2021)

SAP is the market leader in enterprise application software, helping companies of all sizes and in all industries run at their best: 77% of the world's transaction revenue touches an SAP system. They are mostly known for SAP ERP system that is used world widely. In terms of Internet of Things, they reimagine business processes and models with embedded IOT services. Power data-driven business applications with a large volume of sensor data that is fully managed and easy to consume. They developed a Smart Sensing Technology. Smart sensing technology helps to not just exchange this information between physical objects and enterprise applications, but also to track the associated business objects to automatically steer process steps and actions. Cloud technology enables not only the possibility to process large numbers of scanning events in parallel, but also provides a powerful decision and rules engine to "translate" insights to actions, allowing customers to leverage intelligence at almost every business process they can imagine. The smart sensing capabilities are offered as part of SAP IoT and enable customers to automatically correlate the movement of physical objects to specific process steps by scanning ID-tags such as RFID, barcode, QR code, or image recognition. (SAP, 2021)

Siemens is German multinational conglomerate focused on industrial manufacturing. The tremendous quantities of data supplied by the IoT often conceal valuable information that can't be found using simple analytical techniques like statistics. Artificial Intelligence (AI), on the other hand, is generally very successful at accomplishing this kind of task. For example, it can independently recognize patterns in measured values from production and use the information to continuously improve the manufacturing process – making artificial intelligence one of the main reasons that the IoT is booming. At the same time, the Internet of Things is driving the continuous development of AI.

Shell or Royal Dutch shell is British/Netherland company that focuses on petrol/energy business. They have been using IoT sensors to monitor offshore and

onshore oil fields. Due to this, Shell managed to save over one million dollars. The sensors are used to provide pipeline surveillance. It combined IT automation and instrumentation technologies to provide a support platform for remote field data and optimize operations. It uses analysis and data management to provide insight into field processes. It said this would lead to safer and more efficient oilfield operations. (Internet of business, 2021)

Tesla is a leader in manufacturing an electronic vehicle. The company was founded in USA by Elon Musk. They use Artificial intelligence in self-driving cars, they also imbed the IoT sensors inside the cars which can communicate with installed AI in the safest way possible. The power of IoT is that it provides the possibility for companies, like Tesla, to tailor services to their customers and respond in real-time to unforeseen events. And by collecting data from these devices, the companies can optimize their performance going forward. A good example of this is General Electric company, which has begun installing IoT sensors in its aircraft engines, allowing mechanics to remotely monitor the health of individual components and collect data on use, helping to not only prevent engine failure, but also to better monitor usage and wearing tear. (Forbes, 2019)

5 Discussion

There is no clear definition of the Internet of Things, and by comparing different definitions we can say that the authors agree on the main idea that: The Internet of Things is a system (Gillis, 2020) or a network of interconnected objects (Ashton, 1999; Dhonge, 2016; Madakam, Ramaswamy & Tripathi, 2015; Majumdar, 2019; Gartner, 2021; Oracle, 2021). According to the authors, objects are also referred to as devices or things that represent software, sensors, physical objects (electronic devices, buildings, vehicles, etc.) and are connected via the Internet, which allow data collection and exchange; automatically organize and share information; respond and act in the event of changes in the environment; communicate, perceive or interact with their internal states or external environment and provide better services. The authors identify several benefits from using the Internet of Things, and one of them is the ability of stakeholders to communicate quickly and effectively. By connecting components of the environment to the Internet of Things, the percentage of control over the environment is increased, the ability to respond to changes is improved, and the necessary information is immediately available to users and others.

We would like to define our own definition IoT - ***Internet of Things is a digital technology Industry 4.0, which is a network of interconnected devices via wireless connection, which are formed by technological and other components used to connect elements in the enterprise environment and provide various services.***

The Internet of Things can be used in almost all industries. From a review of statistical analyzes carried out by various companies, we found that the Internet of Things has a growing trend of use and is most used in the logistics and utilities industries. Our sample of companies used the Internet of Things to cover several business areas. They agree on increased control over the business process, better

communication between devices in the system and more efficient production. Businesses focus on providing cyber security with respect to the risks of third-party attacks. Active use of cloud solutions enables diversification of this risk. Some of the companies noted the emergence of predictive maintenance of equipment as an advantage of implementing the Internet of Things into the business. Thanks to it, companies are able to prevent possible failures in advance, which would cause greater time and material damage.

The success of IoT depends on security standardization at various levels, which provides assured interoperability, compatibility, reliability and efficiency of operations on a global scale (Li, Tryfonas & Li, 2016). IoT systems According to Majumdar (2019), they improve data collection and automation and remotely control capabilities and flexibility through intelligent devices and assistive technologies.

6 Conclusion

The Internet of Things is a growing global trend for diverse uses across society, whether in consumers, industry, services or others. Currently, it is the largest use in industry, none in the future we expect to expand into the daily life of ordinary people - the possibilities of how the concept of the Internet of Things can be applied are very many. The use of the Internet of Things by businesses is an industrial Internet of Things and is widely used, either in terms of size or industry.

The adoption of digitization and digital transformation in businesses requires a change in business models based on the analysis and identification of applicable digital technologies, the application of which varies depending on the business sector and the subject of the activities performed. The Internet of Things, along with other digital technologies, is as follows: Artificial Intelligence, Cloud Computing, Advanced Robotics, 3D Printing and Big Data analytics are great opportunities for businesses across industries due to operational efficiency, innovation, new business model, competitiveness, better customer profitability experience and profitability.

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Stock performance during Covid-19 pandemic by sector: Conditional value at risk approach

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Abstract. The Covid-19 pandemic affects many areas of our lives, with financial markets being no exception. Comparison of the risk-return patterns of the sector stock indices allows us to draw conclusions on the relative vulnerability of the economic sectors to the underlying pandemic. Previous research suggests that although market was negatively hit in general, it is possible to find small portion of the winners. We used daily prices from the 1.8.2018 to 31.7.2021 on the sector stock indices to assess its risk-return patterns before and during the pandemic. Special emphasis was set on the calculation of the Conditional value at risk. Our results suggest that, although all the sectors reported increased CVaR measures, in terms of the Sharpe ratio most sectors reported higher values in Covid-19 period. IT, Consumer Discretionary and Health care sector showed the lowest relative increase in the riskiness while Real Estate, Utilities, Energy and Materials were hit the most. With regards to the Healthcare sector, the improved performance seems to be driven by the industries of Biotechnology and HC equipment rather than Pharmaceuticals.

Keywords: Conditional value at risk, sector stock indices, financial markets.

JEL classification: *G 10, G 11*

1 Introduction

Covid-19 pandemic represents unprecedented global event, affecting all aspects of our lives, stock market being no exception. The fall of the financial markets provided us with the unique opportunity to assess the performance of the stocks on the sector-to-sector basis, and thus draw conclusions on the relative vulnerability of the sectors for the future.

To this end we have decided to use less common Conditional value at risk methodology to assess the increased risk within the stock market. We have compared the performance of the 11 S&P sector stock indices before and during Covid-19

pandemic based on Sharpe ratio and CVaR 95%. We used the data on the historical prices of the indices ranging from 1.8.2018 to 31.7.2021.

Our results suggest that although all the sectors reported significantly higher CVaR 95 values during the Covid-19 pandemic, pointing to the higher riskiness, the Sharpe ratios showed that it is offset by higher expected returns. In line with previous research the IT, Consumer Discretionary and Healthcare sector showed the lowest relative increase in the riskiness while Real Estate, Utilities, Energy and Materials were hit the most. The performance of the Healthcare sector was driven not by the Pharmaceuticals, but rather by the Healthcare equipment and Biotechnology industries.

2 Review of the literature

Stock prices are said to be equal to the sum of discounted values of expected future cash flows at different investment horizons. Thus, they are vulnerable to the several underlying factors, which might be affecting the expected future returns of the all the sectors within the economy or just some of them. A typical example of such a discriminating factor, studied commonly in the literature, might be the oil price change, that leads to the volatility of the transport sector returns (Arouri and Nguyen, 2010) and other gas related sectors.

On the other side of the scale are factors affecting economy, and thus spilling the increasing the risk measures of the stocks within sectors either by decreasing expected returns or increasing the volatility of the returns. Covid-19 might be considered one such factor. There is a vast body of literature analyzing the linkage of the Covid-19 pandemic and the financial markets. In general, studies conducted during the first year of the pandemic showed, that there were negative volatility shocks in the stock markets. These were reported for example by Baker et al. (2020) or Hassan and Gavilanes (2021) reporting the drop rates of the same scale as during the global financial crisis of 2008. Similarly, Baek et al. (2020), analyzing the US stock market volatility, concluded that total and idiosyncratic risk is significantly increased by Covid-19 pandemic across all industries.

Other stream of literature analyzed the impact of Covid-19 on the stock market on the sector-by-sector basis. Özkan (2021) studied 23 sector indices from the Istanbul stock market between June 2019 and July 2020 and found that volatility jumps had occurred in all sector indices analyzed. He also states that the volatility shocks were asymmetric, with the sports companies being the most hit, while the stocks of the insurance related sector were the least affected. Interestingly, author concluded that the volatility shock disappeared in the march 2020. In contrast, studies from US reported market crash in March 2020 triggered by Covid-19. One such study, conducted by Mazur, Dang and Vega (2021) reported, that despite of the market crash negatively affecting the returns of 90% of the S&P1500 stocks, some sectors, such as healthcare or software stocks earned high positive returns. Similar results are reported by Smales (2021) who analyzed the impact of Covid-19 on the 11 S&P sector indices, used also in our publication, and concluded that the investor attention, measured by the Google search volume might explain, why some sectors were hit stronger than others. Increased

attention helped to realize gains in sectors of Consumer Staples, Healthcare and IT. Study conducted by He et al. (2020) with the use of the data on the Chinese stock market and abnormal average return rate methodology, reports findings supporting the previous studies. However, besides of IT and Healthcare, also education and manufacturing are found to be resilient to the pandemic.

We extend the existing literature by assessing the longer time-period, as we believe, that although the main disturbance in the returns might have been at the beginning of the pandemic, in the long run investors might have used to the new conditions on the market to a certain degree. The pandemic is not over yet, and although we have a relieve in the form of the vaccines, new mutations and governmental restrictions are likely to be still negatively influencing the expectations of the investors. We expect the long run risk measures to be still considerable higher when compared to its pre-Covid counterparts. Secondly, instead of the analysis of the most common volatility measures we aim to compare the 95% Conditional value at risk for the sectors during the 1.5 year before and after the Covid-19 pandemic. This method allows to assess the risk of the indices more conservatively, as it weights the extreme losses more heavily. Special emphasis will be set on the industries within the healthcare sector, where higher volatility is expected, caused by the increased public scrutiny set on the pharmaceutical companies during the quest for the most effective vaccine.

3 Data and methodology

The aim of this paper was to assess the performance of the individual S&P sector indices during the pandemic and their potential role in the portfolio diversification. Additionally, we intended to put special emphasis on the performance of the healthcare related industries during Covid-19 pandemic, as it was reasonable to expect higher attention of the investors towards pharmaceutical companies. To this end we have analyzed 3 years of daily returns of the S&P indices, beginning from August 2018 till the end of the July 2021. To compare the indices performance before and during Covid-19 pandemic we divided this period into two sub-periods of approximately equal length. As a beginning of the pandemic, and thus the breakpoint between two sub-periods, we chose 1.1.2020. We did so because the outbreak of Covid-19 was firstly reported on 31. December 2019 in Wuhan, China and first case of Covid-19 in the US followed on January 21. As the final day of our sample, we used 31.7.2021, which represents the day of the data collection.

We picked sector indices based on the S&P website (2021) and its breakdown of the companies into 11 sectors – Communication services, Consumer Staples, Consumer Discretionary, Energy, Financials, Healthcare, Industrials, Information technology, Materials, Real Estate and Utilities. To follow our interest in healthcare sector we separately also assessed S&P Pharmaceuticals Industry, S&P Biotechnology Industry and S&P Healthcare Equipment Industry, all incorporated in broader Healthcare sector index. The first two are picked due to their importance in the Covid-19 struggle and the last for its increasing importance on the market. Table 1 provides the information on

the top 10 constituents within each Industry. As one can see, both Pharmaceuticals and Biotechnology industries incorporate companies linked to the Covid-19 vaccines.

Table 1. Top ten constituents of chosen healthcare industries, based on S&P website

Industry	Top 10 companies
Pharmaceuticals	Zoetis Inc, Catalent Inc, Eli Lilly & Co, Elanco Animal Health Inc., Pfizer Inc, Johnson & Johnson, Bristol-Myers Squibb, Perrigo Company pls, Jazz Pharmaceuticals plc, Merck & Co Inc
HC equipment	DexCom Inc, ResMed Inc, Inogen Inc, Biolife Solutions Inc, Qidel Corp, Masimo Corp, OraSure Technologies Inc, Hill-Rom Holdings Inc, Danaher Corp. West Pharmaceutical Services Inc
Biotechnology	Intellia Therapeutics Inc., Moderna Inc., Cytokinetics Inc., Celldex Therapeutics Inc, Translate Bio Inc, Arcus Biosciences Inc, Veracyte Inc, ChemoCentryx Inc, Biohaven Pharmaceutical Holding Company Ltd, Kymera Therapeutics Inc

Source: Based on the information from the S&P website.

The data on daily prices were downloaded from the website of spglobal.com for the period from 1.8.2018 to 31.7.2021. All the prices were in USD.

To get preliminary notion on the market development we calculated expected returns and standard deviations of the chosen indices. This was done separately for the pre-Covid-19 and Covid-19 period. Calculated parameters can be seen in Table 2. As the market recovered from the initial Covid-19 hit, one might see that the returns in Covid-19 era are higher for most the stock sector indices. Only exceptions are sectors of Consumer Staples and Utilities. Similarly, in line with the abovementioned studies, standard deviations were alleviated in the Covid-19 era. Interestingly, when the two main industries within HC sector, Pharmaceuticals, Biotechnology and HC equipment are compared, the lastly mentioned is the obvious winner. This is a surprise, considering the hopes related with the vaccinations and the Covid-19 drugs we would expect that higher attention and investments would be put into the Industry of Pharmaceuticals.

Table 2. Expected daily returns and standard deviations of the S&P stock indices by sectors and selected industries.

S&P Index	Pre-Covid19 (8.2018 – 12.2019)		Covid-19 (1.2020 –7.2021)	
	E(r)%	St.dev	E(r)%	St.dev
Com. Services	0.06	0.011	0.12	0.018
Cons. Staples	0.05	0.010	0.05	0.015
Cons. Discre.	0.03	0.011	0.11	0.018
Energy	-0.05	0.013	0.00	0.033
Financials	0.03	0.011	0.07	0.024
Healthcare	0.04	0.010	0.08	0.016

Industrials	0.03	0.011	0.08	0.021
IT	0.07	0.013	0.15	0.022
Materials	0.02	0.011	0.10	0.021
Real Estate	0.05	0.009	0.07	0.021
Utilities	0.06	0.008	0.03	0.021
Pharmaceuticals	0.00	0.013	0.04	0.019
HC equipment	0.02	0.013	0.12	0.019
Biotechnology	0.02	0.019	0.10	0.025

Source: Own calculations, based on the data from the S&P website.

In the practical part of the paper, we will calculate the Sharpe ratios based on the formula: Sharpe ratios for the 13 selected indices.

$$\text{Sharpe ratio} = \frac{E(r) - r_f}{\sigma} \quad (1)$$

where $E(r)$ stands for the average daily return of the index, r_f represents risk free rate of return and σ stands for the standard deviation of daily returns. As risk-free rate we used the return on the one-year US treasury bill of 1.56% published on 1.1.2020 (U. S. Department of the Treasury), which after accounting for 250 trading days, gave us daily risk-free return of 0.00006%.

Once the descriptive statistics were analyzed, we proceeded to the calculation of the Conditional Value at risk and the construction of the efficient frontier for the portfolio consisting of selected indices. As we want to test the performance of the separate S&P sector indices in the investment portfolio and short positions are closer to the speculation than investing, we disregarded them. The efficient frontier is constructed by using Solver function to minimize Conditional Value at Risk - CVaR 95 for the given rate of return. The maximization formula might be specified as follows:

$$\text{Min } CVaR_\alpha(w) \text{ subject to } \mu_p(w) = r_T, \sum_i w_i = 1, w_i \geq 0, \quad (2)$$

where $\mu_p(w)$ is the portfolio mean and r_T is a target return. Weights of the individual constituents are w_i .

Conditional value at risk, is a measure of the expected loss in the left tail given a particular threshold on the percentile of the distribution of outcomes and was introduced by Rockafellar and Uryasev (2000). It addresses several shortcomings of the Value at risk (VaR) method. Firstly, CVaR fulfils the subadditivity condition, not allowing the portfolio to have higher risk than the sum of constituents itself. This is not accounted for by VaR calculation. CVaR exceeds VaR measure and thus leads to the more conservative portfolios (Hafsa, 2015). Generally, in times of the market stability, VaR and CVaR give very similar results, however under conditions of higher volatility, such as Covid-19 pandemic, VaR might not give the full picture of the risks, as it does not take into account the distribution of the losses beyond its threshold.

Consequently, we proceeded to the construction of the efficient frontier based on the weights provided by the Solver function and compared it to the risk-return pattern of individual sector indices.

4 Results and discussion

To assess the risk-profile of the sector indices before and during the Covid-19 we will focus on the Conditional Value at Risk (also known as Expected shortfall). Before doing so, we shortly assess the Sharpe ratio, the parameter which is more suitable for the less risk-averse investors, as it gives the information on the ratio between excess returns and standard deviation for the given period, regardless the distribution of the losses. This will provide us with the hindsight on the development of the sector stock indices. Results are reported in Table 3.

Regarding Sharpe ratios, one might see that, besides Consumer staples, Utilities and Real Estate the parameter improved for all the other sectors. Obvious winner is the sector index of Materials, which reported the five-fold higher value of the Sharpe ratio in the Covid-19 era. However, the caution while interpreting the results is needed is needed, as it is questionable what value of risk-free rate to use for the calculation of the excess returns. The results could vary greatly depending on choice.

Table 3. Sharpe ratios and CVaR 95% of the S&P stock indices by sectors and selected industries. Risk free rate based on the 1Y Treasury bond from 1.1.2020 equal to 1.56%.

S&P Index	Pre-Covid19 (8.2018 – 12.2019)		Covid-19 (1.2020 –7.2021)	
	Sharpe	CVaR	Sharpe	CVaR
Com. Services	0.047	0.027	0.062	0.044
Cons. Staples	0.040	0.019	0.027	0.036
Cons. Discre.	0.024	0.028	0.056	0.046
Energy	-0.041	0.032	-0.002	0.075
Financials	0.023	0.026	0.026	0.058
Healthcare	0.038	0.024	0.044	0.040
Industrials	0.019	0.027	0.034	0.052
IT	0.050	0.034	0.066	0.053
Materials	0.009	0.025	0.047	0.050
Real Estate	0.045	0.022	0.032	0.055
Utilities	0.064	0.019	0.011	0.051
Pharmaceuticals	-0.005	0.032	0.019	0.044
HC equipment	0.011	0.031	0.063	0.045
Biotechnology	0.008	0.041	0.039	0.055

Source: Own calculations, based on the data from the S&P website.

As for the focus of the research, we assess the values of CVaR for chosen stock indices. Values are reported in the Table 3. The graphical demonstration of the relation between Expected returns and CVaR 95% in Covid-19 period is provided in the Figure 1, together with the efficient frontier build from the indices. CVaR can be interpreted as a weighted average of the 5% of the losses. The results show, in line with the expectations, that all the CVaR parameters increased by 1.4 to 2.7 times when compared to the pre-Covid period. The highest relative rise is reported in the sectors of Utilities, Real Estate, Energy and Materials. While an investor in Utilities lost on

average 1.8% on the worst 5 out of 100 trading days before the Covid-19 pandemic, the value lost during the pandemic would be 5.1%. Similarly, instead of losing on average 2.1% in the 5 worst days out of 100 days, investor in Real Estate loses 5.5% in pandemic. The riskiest sector based on the expected shortfall is Energy sector, in which the 95% CVaR equals to 7.5%.

On the other hand, the least impacted sectors based on this measure were IT, Consumer Discretionary and Healthcare. While CVaR in IT before the pandemic was 3.4%, being the highest from all the sectors, it raised only 1.57 times to the value of 5.3% during the pandemic. Although still rather high, it lost the position of the riskiest sector based on CVaR to the Energy and is also surpassed by Financials and Real Estate.

As for the Healthcare sector, the value of CVaR 95 increased from 2.4% to 4%. When focused on the two main industries within the sector, Pharmaceuticals and Healthcare equipment, we can see comparable development within both indices. However, the indifference disappears once the values are mapped to the expected returns. Surprisingly, Healthcare equipment outperforms Pharmaceuticals greatly, offering 3 times higher returns for the same value of CVaR. Even the Biotechnology offers better Sharpe ratio than the Pharmaceuticals, however, its CVaR is 1 percentage point higher. Thus, in conclusion, the positive performance of the HC sector relative to the other sectors is driven not by the industry of Pharmaceuticals but rather the performance of the Healthcare equipment and Biotechnology industries.

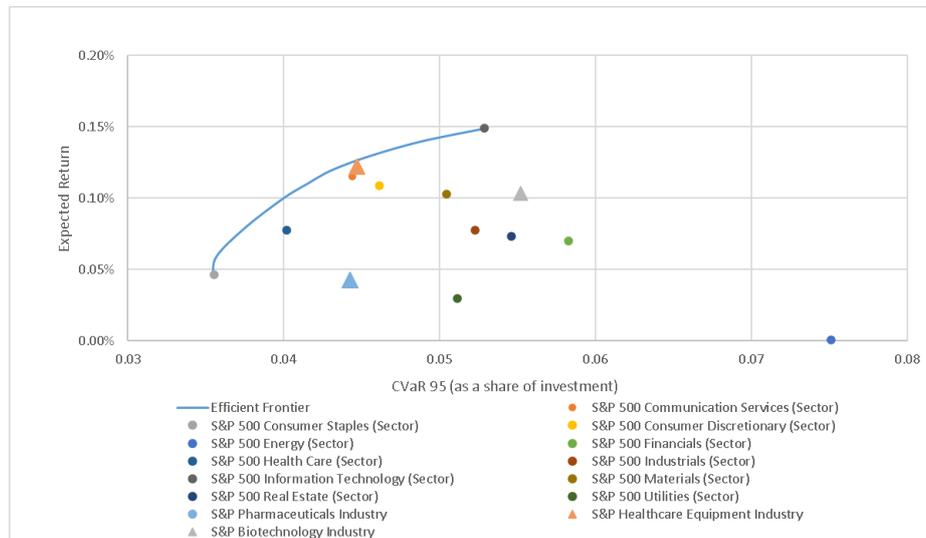


Fig. 2. Efficient frontier and individual S&P indices. Based on the data from the S&P website.

Regarding the relation between CVaR 95 as a risk measure and the expected return, shown in Figure 1, the efficient frontier runs through Consumer staples and IT sector indices. Other indices in its close neighborhood are Communication services, Healthcare and Consumer Discretionary.

Our results are in line with Smales (2021) and He et al (2020), supporting the notion that IT and Healthcare did the best during pandemic. Even in the prolonged period of analysis these two sectors showed the lowest relative increase in the risk-measures. Surprisingly, our results showed that within the HC sector the performance of the Healthcare equipment industry outperforms the industry of Pharmaceuticals.

Results also showed the increased volatility of the sectors related to physical goods. Significant increase in the riskiness of Energy and Materials stock index, might be attributed to lockdowns and restrictions in transportation and manufacturing due to the pandemic. Increased riskiness of the Real Estates is also likely to be attributed to the restrictions when less people had to change the residence as the work was conducted often from house. The most surprising comes the underperformance of the Utilities in comparison to the period before the Covid-19 outbreak. Although one would have expected that because of the home office the usage of the electricity would go up thus creating demand and attracting investor attention, the same goes for water. However, the Sharpe ratio declined 6 folds. The possible reason is the lower demand by the companies which had outpaced the home usage.

5 Conclusions

Although Covid-19 pandemic has increased the volatility of the whole market, regardless the sector, there are still sectors that were hit less than the others. Comparing the CVaR 95% we conclude that the CVaR of the sector indices is higher from 1.4 to 2.7 times in comparison to the pre-Covid period. The highest rise of the CVaR is reported in the sectors of Utilities, Real Estate, Energy and Materials. The Sharpe ratios also showed that Utilities had the highest drop in performance sector. Except for the Consumption Staples and Utilities, other sectors actually reported increased Sharpe ratio for the Covid-19 period, suggesting that the market has recovered.

In line with previous research the least impacted sectors based on the chosen measures are IT, Consumer Discretionary and Healthcare. Interestingly, the performance of the Healthcare sector was driven more by the industries of Healthcare equipment and Biotechnology than the classical Pharmaceuticals, although there are several companies producing Covid-19 vaccines within this industry.

The biggest drawback of our paper is how to define the period of the Covid-19 pandemics. As the restrictions are still set in many countries, we have decided to analyze the data up to July 2021, however we are aware that the main rise in the volatility was present in the first half of 2020. Increased volatility is likely to disappear in the future research as the longer and longer period will be analyzed. As the CVaR cares about the distribution of the worst losses, it will remain affected longer than traditional measures such as VaR. It would be viable to try to analyze CVaR on the month-by-month bases and see how the volatility settled or increased over time.

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Personnel controlling tools in the era of industry 4.0

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Abstract. The aim of this paper is to contribute to the discussion of personnel controlling tools and changes that occur as a result of Industry 4.0 through a literature search. We have used basic scientific methods, such as analysis, synthesis, generalization, comparison, induction and deduction, to develop a literature search. By studying the topic, we performed an analysis of current knowledge about selected personnel controlling tools and changes in the Industry 4.0 era. Schulte (2020) considers strategic planning of the workforce and requirements, employee surveys, balanced scorecard, benchmarking and process model of personnel analytics to be selected tools of personnel controlling. We also identified changes that occur in the researched topic in the context of Industry 4.0 era. These changes are the increasing digitization of individual tools due to the increase not only in the volume of data being processed, but also in the speed at which the data is processed. It uses analytics that include methods for the highest degree of automation of recognition and the use of patterns, contexts and meanings. Statistical methods, predictive models, optimization algorithms, data mining, text and image analysis are also used. Innovative solutions for virtual environments are transforming people management tools by automating manual processes and optimizing the implementation of strategic tasks. It is in the interest of companies to adapt to change to remain competitive.

Keywords: personnel controlling, tools, industry 4.0

JEL classification: M19, M50

1 Introduction

Since about 1990, personnel controlling has been an important part of strategic human resource management, providing a wide scope for research. Personnel controlling is often identified with monitoring in terms of supervision or control, but this does not

capture the idea and interest in controlling. Controlling is a management concept and therefore has a much wider scope. Research in this area is becoming increasingly important as the company's success is increasingly focused on personnel, especially in industries that are personnel intensive (Preitler, 2012). In the global world, revolutionary changes are taking place in the field of technology and technologies based on the use of information and communication technologies. Human capital plays a key role in all these processes as the creator of these changes, but also as an actor on the side of their use and improvement. Digitization changes people management, both in terms of value and methodology. The content of performance and the path to performance are changing. Tools and techniques for obtaining performance information need to be adapted. One of these topics is personnel controlling, which is used to analyze personnel data. It primarily focuses on trend analysis and strategic personnel planning, but also on the early recognition of deficiencies in various areas, as well as on personnel development, performance management, employee retention and performance stimulation.

With advancing technologies, personnel controlling must develop tools to assess the impact of personnel work on profit. However, this does not only mean exercising control over this activity from a purely economic point of view. Personnel controlling can be performed effectively if the personnel controller has knowledge of quantitative accounting systems as well as qualitative behavioral effects and can combine both.

Unlike traditional personnel controlling, where the main function of controllers was to pay salaries, control working hours and basically manual and bureaucratic activities, personnel controlling 4.0 focuses on efficiency in a broader context, on areas such as attracting qualified talent, planning necessary employee competencies, performance management in line with the company's strategy and employee interests, as well as improving the organizational climate and other approaches that directly contribute to the company's strategic results. Personnel controlling 4.0 is permeated by technology and is in line with new labor market scenarios. The trend of people orientation and humanization of work is becoming a reality. Organizations use IT support to automate repetitive, uncreative, and unattractive work.

Perhaps the most important influence that distinguishes traditional personnel controlling from personnel controlling 4.0 is the so-called digital transformation. Companies today have a greater tendency to adopt online tools and use digitized methods or techniques. Innovative virtual solutions and resources help operations both manage people and automate manual processes and optimize strategic tasks. From talent search and planning, through performance management to control itself, bureaucratic processes are performed with a minimum of human intervention, which creates more space for HR 4.0 professionals for complex analysis and strategic orientation and requires less for operational performance.

People analytics can improve the transparency of decisions, and employee development can derive performance for the future from past data and, in particular, contribute to improving employee selection and development. For example, applying comparison algorithms can improve the matching of skills to jobs or create them at all in many companies. Skills gaps analyzes may suggest the addition of skills and job requirements to employees, and path-finding algorithms may suggest individual training programs. This thematic area is based mainly on computer-assisted evaluation.

2 Research design

The aim of this paper is to contribute to the discussion of personnel controlling tools and changes that occur in personnel controlling tools in the context of Industry 4.0 through a literature search. Schulte (2020) considers strategic planning of the workforce and requirements, employee surveys, balanced scorecard, benchmarking and process model of personnel analytics to be selected tools of personnel controlling.

We used available domestic and foreign sources to analyze the topic, which describe the individual tools in more detail. We have analyzed the study published in registered databases, which deal with the content of this management concept and changes in personnel controlling due to the digital transformation of companies.

Through obtained information, we get to the theoretical processing of the topic. We have used basic scientific methods, such as analysis, synthesis, generalization, comparison, induction and deduction, to develop a literature search. By studying the topic, we performed an analysis of current knowledge about personnel controlling tools and changes in the Industry 4.0 era.

Based on the set goal, two research questions were formulated:

RQ1: What are the currently available tools for personnel controlling?

RQ2: What changes in personnel controlling tools are taking place in the context of Industry 4.0?

We answered the research questions in the following part of the theoretical research.

3 Results and discussion

Various tools are used to achieve the goals of personnel controlling. It is often possible to encounter these tools in another area of business management, because they are standard control tools that have been modified in some way and adapted to the needs of personnel management and at the same time digitally transforming times. Development challenges remain to be met in this area. Ackermann and Scholz (1991) state that a number of individual tools are known which focus on analysis, planning, management and control. However, personnel controlling needs comprehensive tools to perform its functions in order to capture all the necessary aspects.

Urban (2008) characterizes the tools of personnel controlling as the main methods used to analyze and evaluate the level and results of human resource management in the company. He divided the personnel controlling tools in accordance with the basic division into quantitative, qualitative, operational and strategic, while he considers the audit of human resources management, personnel standards, personnel indicators and employee surveys to be personnel controlling tools.

- The human resources management audit is a tool of strategic personnel controlling used to assess the objectives of human resources management, its

effectiveness, methods and longer-term results. It concerns the assessment of the compliance of personnel processes with generally applicable rules (decrees, laws, regulations).

- Personnel standards are based on the company's intentions, we distinguish quantitative (defining the target values of indicators that should be achieved) and qualitative (characterizing the rules or principles of human resource management.)
- Personnel indicators are aggregates, usually relative, that express the proportion or relationship between several variables. They monitor the quantitative results of human resource management and are more operational. However, to some extent they reflect strategic aspects and can provide an idea of the quality of human resource management.
- Employee survey is a tool used to evaluate the qualitative characteristics of employees, e.g. skills, motivation, satisfaction, loyalty, etc.

The previously outlined tools of personnel controlling have been mentioned based on the author's clear and practice-oriented approach to the subject. Some of the early concepts are still relevant today and have been the pillars of building new tools for the modern concept. In the further context of this paper, we identify and characterize personnel controlling tools that are increasingly coming to the fore in digitally transforming companies under the influence of the 4.0 era, based on a publication by Schulte (2020):

Strategic workforce planning and requirements

The aim of the strategic workforce management concept is to comprehensively assess strategic options from a staffing perspective and to ensure at an early stage that corporate plans can be implemented with the necessary competencies. This requires an accurate knowledge of market drivers, competition and technology. The requirements for the human resources department are the need for qualitative orientation, the creation of a long-term perspective as well as the ability to create scenarios (Sattelberger and Strack, 2009).

- Qualitative orientation: a key contribution of the human resources department in the context of the strategy discussions must be the clear identification and analysis of the key competencies that will be needed in the future.
- Creating a long-term perspective: a sufficiently long planning period is needed to take full account of the effects of strategic options or plans.
- Ability to create scenarios: Due to the high degree of uncertainty in strategic planning, several scenarios are often analyzed depending on the defined influencing variables. In order to discuss potential personnel effects and requirements, a flexible simulation option with parameter support is very useful.

The concept of strategic workforce planning can be implemented in the following five steps (Sattelberger and Strack 2009):

- I. Strategy-based segmentation - the first step is to create a meaningful system of grouping jobs. This system should explicitly map expected changes in skills from a strategic point of view, for example by introducing a technological, product or market dimension into the definition of the required group. In order to be able to derive specific measures from the subsequent analysis of deficiencies, it must be possible to deal specifically with the stocks of employees recorded in the various groups.
- II. Inventory simulation. In this case, it is a workforce forecast that assumes different scenarios (e.g. no staffing measures, different retirement scenarios). This analysis provides information on where unbalanced age structures will lead to a lack of the company's own personnel capacity in the future.
- III. Demand modeling. In the third step, personnel requirements for individual work groups will be determined using driving force models that illustrate the long-term development of business and productivity, as well as sensitivity and scenarios.
- IV. Analysis of differences. The results of the inventory and demand simulation are reflected in a gap analysis, which shows the difference between staff demand and inventory for each job group during the planning period.
- V. Derivation of personnel measures. In order to compensate for overcapacity and undercapacity, options can in principle be considered, such as: qualification of staff, redeployment of staff from surplus to shortage areas, implementation of training, recruitment, training and further training, etc.

Employee survey

Employee surveys have been used with great success as a strategic management tool for more than 40 years. It offers the possibility of direct survey among employees. As synonymous terms we can consider e.g. corporate climate analysis, employee satisfaction analysis, employee feedback, etc.

Employee surveys use four target groups: for employees it is a tool for targeted improvement of working conditions, for management it is a tool for strategic control in performance management, measurement tools for analyzing corporate culture and for managers it is a tool for development (Mönninghoff, 2013). As part of the employee survey, employees can report complaints anonymously, but also state what they are very satisfied with. Based on the results, the needs for improvement and successes will be transparently identified. Ideally, subsequent team-level processes give employees the opportunity to actively help develop their immediate work environment. If the results of the survey are actively discussed in the dialogue between management, managers, employees and works councils, this process is an essential component of a

participatory management style. In this way, employees can regularly critically examine work processes, working conditions and information flows and optimize them in a targeted manner.

Balanced Scorecard

The Balanced Scorecard method was developed in the early 1990s as part of a research project led by Robert S. Kaplan and David P. Norton. The authors describe their system of indicators as "balanced" because the company's performance is planned and controlled from four different perspectives (Kaplan and Norton, 1992).

- Financial perspective: key financial data provide information on whether the implementation of the strategy leads to improved financial results. Typical key financial data are the return on investment and the development of the company's value.
- Customer perspective: the task of the customer perspective is to present the company's strategic goals with respect to the customer and the market segments being worked on. Key data, objectives and measures should be developed for the identified customer and market segments.
- Internal processes perspective: within the perspective of internal processes, processes are mapped that have a significant impact on the achievement of financial and customer goals. Typical key figures are delivery times, quality or productivity.
- Learning and Growth Perspective: The fourth and final perspective of the Balanced Scorecard includes goals and indicators to support learning and organizational development. The education and growth perspective describes the infrastructure needed to achieve the three perspectives mentioned above, but also to emphasize the need to invest in the future.

In order to take into account the peculiarities of personnel management, the perspectives proposed by Kaplan and Norton can be modified as follows (Tonnesen, 2000):

- Profitability perspective = measuring the contribution of personnel work to financial success or economic performance. Specifically, we can include, for example, added value (per employee) or cash flow (per employee), personnel costs, key productivity data (per employee or per team), etc.
- Employee perspective that takes into account the work and management situation as a key factor influencing employee satisfaction. These include: key data on employee satisfaction (indices), absenteeism rate, turnover rate, women's quota, average age, part-time rate, hierarchy and team structures, etc.
- A quality perspective that is used to measure quality in the personnel area. These are, for example, target deviations from reality, error rate, number of complaints, success rate, number of solved problems, etc.
- A perspective of knowledge and learning that takes into account the foundations of the future development of society. We can include here, for example: days of training per employee, the number of proposals for

improvement, their rate of implementation and the corresponding value, expenditure on further education, etc.

Benchmarking

Benchmarking is an objective comparative assessment of business structures, processes, costs and technologies based on indicators that are the result of direct analysis of data and information from a company, competing companies or companies in another sector (Berens, 1997). The aim of benchmarking is to learn from the procedures and processes used by the best practices, so that it is possible to subsequently transfer or directly "copy" best practices in a modified form suitable for own company. The best values obtained during the analysis are referred to as reference values, the difference between the baseline situation and the reference value as a gap. After an in-depth analysis and comparison of the process with one or more "partners", it is necessary to close this gap by taking appropriate measures. Adopting best practices often also means breaking paradigms. This must be followed by continuous improvement of one's own processes (Sänger, 1996).

Benchmarking is characterized by the following main features (Berens, 1997):

- **Process orientation:** part of benchmarking is the need to identify, define, quantify, compare and improve operational processes using relevant measured variables.
- **Continuity:** benchmarking should not be done on a one-off basis, but should be a continuous process of self-renewal and improvement.
- **Partnership:** without a willingness to provide information and openness on the part of all stakeholders (whether internal or external), the benefits of benchmarking are limited, if not completely questioned. The comparison units should be considered as partners exchanging information on common processes in the framework of the cooperation.
- **Actions:** the meaningfulness of the results and their acceptance depends to a large extent on the definition of appropriate actions and their uniform recording for all key activities.
- **Holistic approach:** benchmarking can be used in all areas of the company. The object of consideration should not be the isolated individual functions, but the whole sequence of related activities.

The main subject of personnel benchmarking is the comparison of personnel functions or personnel department as an organizational unit, as well as specific personnel processes. When comparing the personnel function, structural data are determined, which represent the size and design of the personnel department. On this basis, it is possible to develop key data against which the human resources departments of different companies can be compared (eg the number of employees in the human resources department per 100 employees). In order to compare HR processes, data on processes such as recruitment or payroll accounting is collected. The goals that the company pursues when using this tool can be e.g. reducing costs in the human resources

department, speeding up processes or improving the quality of employees' work results. Urban (2008) considers the following to be the most common areas of comparison in the field of human resources:

- productivity and added value
- salaries and employee benefits,
- absences and fluctuations,
- recruitment and employee selection,
- training and development of employees,
- workforce structure.

Internal benchmarking involves comparisons between companies to identify internal "best practices", e.g. divisions, personnel departments, etc. Thanks to direct access to big data through various cloud solutions, data collection in this case is relatively simple and results can be achieved in a relatively short time. In contrast, external benchmarking involves all forms of comparison with other companies. It can be direct competitors, other companies from the same sector or companies from other sectors.

Process model of people analytics

Due to the growing digitization of the entire value chain, not only the volume of processed data is growing exponentially, but also the speed at which data are processed. In addition to the availability of an increasing amount of data that can be used, more powerful data analysis capabilities have been developed in recent years (advanced analytics). Real-time data processing for increasing volumes of data is made possible by advanced database technologies. This also increases the attractiveness of using multidimensional statistical methods for relationship recognition, simulation methods, and data mining methods, text, processes, the web, and media for automatic pattern recognition (Wickel-Kirsch, 2019).

Analytics includes methods for making pattern, context and meaning recognition and use as automated as possible. Statistical methods, predictive models, optimization algorithms, data mining, text and image analysis are used. As a result, previous methods of data analysis have been greatly expanded. Emphasis is placed on the speed of analysis (in real time) and at the same time ease of use, which is a decisive factor in the use of analytical methods in many areas of society. One of these areas is the area of human resources management.

People analytics, also referred to as HR analytics or workforce analytics or talent analytics, involves the collection, analysis and reporting of a variety of HR data. It enables businesses to measure the impact of a range of HR metrics on overall business performance and make data-driven decisions. In other words, HR analytics is a big data approach to human resource management. It is a relatively new tool, so it is still largely unexplored in the research literature. The most well-known definition of scientific HR analytics is from Heuvel and Bondarouk. According to them, HR analytics is the systematic identification and quantification of people who are the driving force of business results (Heuvel and Bondarouk, 2016). It involves the interconnection and use of multiple company and personal data based on IT-supported data analysis. The central

goal is to make human resources decisions more analytical and fact-based, i.e. decision-making based on knowledge (evidence-based human resource management). The process model of HR analytics can be used to implement this tool, which assumes three phases (Reindl and Krügl, 2017):

- I. Qualitative phase:
 1. specifically define the problem (as simple and specific as possible, preferably in one sentence; without anticipating a solution, if possible, formulate it as an open question or topic),
 2. gather information and understand the overall context (the goal is to identify the factors that affect or are related to the problem),
 3. develop specific testable hypotheses.

- II. Quantitative phase:
 4. developing own research proposal. Creating a database for analysis. It includes these sub-steps:
 - a) developing an understanding of data (exploring available data, data types and data sources),
 - b) defining data protection rules,
 - c) data collection,
 - d) data preparation and data quality control,
 - e) selection of appropriate analysis procedures,
 - f) testing the analysis procedure on a manageable data set.
 5. Data analysis with the whole data set and evaluation of the quality of the results. The analysis either refutes or confirms the hypotheses developed in step 3. Using the findings from steps 2 and 3, the results of the analysis are then interpreted in the context of corporate reality (are the results meaningful? If not, which results are particularly surprising? How can they be explained? What do these results mean for everyday work?)

- III. Implementation phase:
 6. Visualization - test results should be presented in simple, clear reports to be as clear and comprehensible as possible.
 7. Implementation in the company by drawing up recommendations for actions that form the basis for the company's change processes.
 8. Evaluation of the results of the implementation project in order to gain knowledge for future analytical projects of people.

4 Conclusion

Through the study of domestic and foreign professional literature on personnel controlling as a management concept, we have currently provided answers to established research questions. First of all, we have defined currently available personnel controlling tools, which can include strategic planning of the workforce and

requirements, employee surveys, balanced scorecard, benchmarking or process model of people analytics. We also identified what changes in personnel controlling tools are taking place in the context of Industry 4.0. These changes are the growing digitization of individual tools due to the increase not only in the volume of processed data, but also in the speed at which the data is processed. It uses analytics that include methods for the highest degree of automation of recognition and the use of patterns, contexts and meanings. Statistical methods, prediction models, optimization algorithms, data mining, text and image analysis are also used. Innovative solutions for virtual environments are transforming people management tools by automating manual processes and optimizing the implementation of strategic tasks. From talent search and planning, through performance management to control itself, bureaucratic processes are performed with a minimum of human intervention, which creates more space for HR 4.0 professionals for complex analysis and strategic orientation and requires less for operational performance.

Today, companies are more likely to implement online tools and use the digital environment for performance. There is a value transformation, which brings new methods, tools and a new essence of value-creating activities of companies. Thus, there are also changes in the tools for measuring the new nature of performance. The COVID-19 pandemic has limited the number of companies in their traditional operation in the physical space, and many have been forced to digitize and automate operations and processes that are not necessarily performed by humans, but also use various online platforms, etc.

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Analyzing the interactions of monetary and fiscal policy in a small open economy using a DSGE model

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Abstract. The principal aim of this paper is to estimate a small open economy dynamic stochastic general equilibrium (DSGE) model with monetary and fiscal policy and analyze the interaction of these policies in Hungary. In the paper we present the model in a log-linearized form. We combine both calibration and Bayesian estimation to obtain parameter values of the model. We find that the model is suitable for impulse response analysis, so we estimate the impulse response functions of the model. We examine how five endogenous variables – namely output, inflation, the nominal interest rate, government spending and government revenue – react to non-systematic shocks to the nominal interest rate, government spending and government revenue. The plotted impulse response functions allow us to study how monetary and fiscal policy interacts in a small open economy. In some cases we find that restrictive fiscal policy is accompanied by expansive monetary policy, while in other cases the policy responses to shocks are coordinated. We conclude that our results are in accordance with economic theory.

Keywords: DSGE model, Fiscal policy, Monetary policy

JEL classification: B 23, C 01, E 60

1 Introduction

Standard New Keynesian dynamic stochastic general equilibrium (DSGE) models lack an active fiscal sector. Usually, fiscal policy is only represented in the model in the form of government expenditures. Based on the assumption that fiscal policy only plays a passive role, government expenditure is usually an exogenous process in these models. As a result of this, the possible interactions between monetary and fiscal policy are ignored. However, Ratto et al. (2012) recently published a model

of the Eurozone which includes a comprehensive fiscal sector. Because active fiscal policy is becoming increasingly popular, we include an active fiscal sector in our model. This way we can study the interactions of monetary and fiscal policy in Hungary similarly to Algozhina (2012). We, however, not only calibrate parameter values, but also employ Bayesian estimation techniques to estimate impulse response functions using data available for the period after the Great recession. We also include a backward looking price setting mechanism in the New Keynesian Phillips curve, which is uncommon in the literature. Despite this, we find that a substantial portion of firms sets their prices based on historical information.

In the next chapter we present our model. Then we calibrate and estimate the parameter values. In the fourth chapter we present and analyze the impulse response functions. The last section concludes.

2 The model

In this subchapter we present the log-linearized model equations. For a full model description please refer to Galí and Monacelli (2005, 2008), Çebi (2013) and Galí and Gertler (2000). The method of log-linearization is characterized in Uhlig (1995). The steady state value of each variable below is zero, because they are defined as deviations from their respective steady state values.

To begin with, the representative household of a small open economy is infinitely lived and allocates resources between consumption and investment to maximize its discounted utility function. It has access to international financial markets. Because of this, it can invest in both domestic and foreign bonds with a one-period maturity. To finance consumption and investment, it offers labor and receives wages. The log-linearized IS curve is given as

$$y_t = E_t\{y_{t+1}\} - E_t\{\Delta g_{t+1}\} + \alpha(\omega - 1)(\rho_{c^*} - 1)c_t^* - \frac{1}{\sigma_\alpha}(r_t - E_t\{\pi_{H,t+1}\}) \quad (1)$$

where α is the degree of openness, c_t^* is an exogenous AR(1) process representing world output with ρ_{c^*} being the autoregressive parameter., while ω and σ_α are parameters defined as

$$\omega = \sigma\gamma + (1 - \alpha)(\sigma\eta - 1) \quad (2)$$

$$\sigma_\alpha = \frac{\sigma}{(1 - \alpha) + \alpha\omega} \quad (3)$$

where γ is the elasticity of substitution between domestic and foreign goods, η is the elasticity of substitution between foreign goods from different countries, while σ represents the inverse elasticity of substitution in consumption. Besides these parameters it is also important to define the endogenous variables. Firstly, output y_t is defined as $y_t - \bar{y}$, where \bar{y} represents the steady state value of output. Secondly, government spending is given as $g_t = -\ln\left(1 - \frac{G_t}{Y_t}\right)$. Thirdly, the nominal interest rate

is given by r_t . Fourthly, domestic inflation is represented as $\pi_{H,t} = \ln\left(\frac{P_{H,t}}{P_{H,t-1}}\right)$, where $P_{H,t}$ is the CPI.

To continue with, equation (4) represents the log-linearized open economy hybrid New-Keynesian Phillips curve which includes both forward- and backward-looking price setting mechanisms of firms

$$\pi_{H,t} = \lambda^b \pi_{H,t-1} + \lambda^f E_t \{\pi_{H,t+1}\} + \kappa mc_t \quad (4)$$

where τ is the log-linearized government revenue equation, mc_t represents real marginal cost, κ is the slope coefficient and λ^b and λ^f are parameters defined as

$$mc_t = (\sigma_\alpha + \varphi)(y_t - y_t^n) - \sigma_\alpha g_t + \tau \quad (5)$$

$$\lambda^b = \frac{\xi}{\theta + \xi(1 - \theta(1 - \beta))} \quad (6)$$

$$\lambda^f = \frac{\beta\theta}{\theta + \xi(1 - \theta(1 - \beta))} \quad (7)$$

$$\kappa = \frac{(1 - \beta\theta)(1 - \theta)(1 - \xi)}{\theta + \xi(1 - \theta(1 - \beta))} \quad (8)$$

In equation (4) the output gap ($y_t - y_t^n$), government spending (g_t) and taxation (τ) indirectly affects inflation via the real marginal cost. The sensitivity of inflation to real marginal cost is represented by the slope coefficient κ . Secondly, κ and the remaining two structural form parameters of the Phillips curve are represented by three deep model parameters, namely the discount factor (β), the Calvo parameter (θ) and the parameter representing backward looking firms (ξ). If $\xi = 0$ then we have a forward looking New-Keynesian Phillips curve, otherwise the Phillips curve is hybrid. If $\beta = 1$, the sum of the parameters of forward and backward looking inflation equals to 1. What is more, the value of λ^b and λ^f falls between β (if $\xi = 0$) and 1 (if $\xi = 1$). Because β is always close to 1, λ^b and λ^f represent the relative weights given to past and expected inflation. From this we can conclude that if the number of backward looking firms increases and price stickiness is high then current inflation is less sensitive to current real marginal cost.

The third agent in the model is the central bank, which is represented by the monetary policy rule formulated by Taylor (1993) as

$$r_t = \rho_r(r_{t-1} - r_t^n) + (1 - \rho_r)[r_\pi \pi_{H,t} + r_y(y_t - y_t^n)] + r_t^n + \epsilon_t^r \quad (9)$$

where ρ_r represents the degree of interest rate smoothing, r_π represents the monetary authority's reaction to inflation, r_y represents the monetary authority's reaction to the output gap and ϵ_t^r is an i.i.d non-systematic policy rate shock. y_t^n represents potential output while r_t^n is the natural interest rate, so we can write that

$$y_t^n = \frac{(1 + \varphi)}{(\sigma_\alpha + \varphi)} a_t - \frac{(\sigma - \sigma_\alpha)}{(\sigma_\alpha + \varphi)} c_t^* \quad (10)$$

$$r_t^n = \sigma_\alpha(E_t\{y_{t+1}^n\} - y_t^n) + \sigma_\alpha\alpha(\omega - 1)(\rho_{c^*} - 1)c_t^* \quad (11)$$

where φ is the inverse elasticity of labor supply and a_t represents the AR(1) technology process.

The last part of the model is the fiscal block. Government spending is given as

$$g_t = \rho_g g_{t-1} + (1 - \rho_g)[g_y(y_{t-1} - y_{t-1}^n) + g_b b_t] + \epsilon_t^g \quad (12)$$

and taxes are represented as

$$\tau_t = \rho_\tau \tau_{t-1} + (1 - \rho_\tau)[\tau_y(y_{t-1} - y_{t-1}^n) + \tau_b b_t] + \epsilon_t^\tau \quad (13)$$

In this paragraph we characterize the parameters of equations (12) and (13). Firstly, parameters ρ_g and ρ_τ represent the fiscal spending smoothing and tax smoothing parameters, respectively. Secondly, parameters g_y and τ_y represent the reaction of government spending and the lump sum tax to changes in the lagged output gap. Thirdly, parameters g_b and τ_b represent the reaction of government spending and the lump sum tax to changes in the debt stock. Lastly, we have the exogenous i.i.d fiscal shocks, namely ϵ_t^g and ϵ_t^τ , which represent the non-systematic changes in government spending and the lump sum tax. From these equations we can see that in the presence of a high degree of fiscal smoothing the reactions of government spending and tax to lagged output gap and debt are smaller.

The fiscal block includes the fiscal constraint as well, which we can write as

$$b_{t+1} = r_t + \frac{1}{\beta} \left[b_t - \pi_{H,t} + (1 - \beta)(\tau_t - y_t) + \frac{\bar{C}}{\bar{B}}(g_t - \tau_t) \right] \quad (14)$$

where $b_t = \ln\left(\frac{B_t}{P_{H,t-1}}\right)$ is a predetermined variable, B_t is nominal debt, \bar{C} is the steady state value of private consumption to GDP ratio and \bar{B} is the steady state value of the debt to GDP ratio.

3 Parameter estimation and calibration

To plot impulse response functions and reach meaningful conclusions, we first need to assign values to the parameters in the model. We do this by combining two methods. We split the parameters into two groups. The parameters in the first group are calibrated, while the parameter values in the second group are obtained using Bayesian estimation. Table 1 presents the calibrated and table 2 presents the estimated parameter values.

At first, we describe the calibrated parameters in Table 1. These parameters are calibrated because their values are almost identical in most studies. Firstly, we borrow the value of the degree of openness from a DSGE model calibrated for the Hungarian economy. We set this parameter's value at 0.69 as in Algozhina (2012). Secondly, the parameters representing the elasticity of substitution between domestic and foreign goods and the elasticity of substitution between foreign goods from different countries were set at 1.00. This value is also borrowed from another research

paper Çebi (2013). Thirdly, the value of the discount factor is calibrated to 0.99 based on two previous DSGE models calibrated and estimated for the Hungarian economy by Jakab and Kónya (2016) and Jakab and Világi (2008). Finally, the last two parameters, namely the steady state values of the private consumption to GDP ratio and the debt to GDP ratio are set at 0.51 and 0.78, respectively. We obtain these values by calculating the sample means for the estimation period. To sum up, we calibrate these parameters because their values are given in most studies or can be easily calculated. The rest of the parameters are estimated using Bayesian techniques.

Table 1. Calibrated values.

Parameter	Calibrated value
α	0.69
η	1.00
γ	1.00
β	0.99
\bar{C}	0.51
\bar{B}	0.78

To continue with, we describe how we selected the probability distributions, prior means and prior standard deviations of the remaining model parameters. The probability distributions, prior means and standard deviations are presented in Table 2. Firstly, we use the same probability distributions as Çebi (2013) used to estimate similar DSGE models. We use beta distributions for parameters whose value falls between zero and one. Inverse gamma distributions are used for the shocks so they cannot have negative values. Secondly, we obtain the prior means and standard deviations either by borrowing them from other studies or by running regressions in EViews. The latter, namely the OLS regressions, are used to obtain prior means and standard deviations for the autoregressive parameters of world output, government spending and taxation. The former method is used for the rest of parameters.

Table 2. Parameter estimates.

Parameter	Prior mean	Prior standard deviation	Posterior mode	Posterior standard deviation	Posterior mean	Lower 90% confidence band	Upper 90% confidence band
θ	0.93	0.02	0.97	0.006	0.97	0.956	0.977
φ	3.00	0.20	2.98	0.20	2.98	2.659	3.304
σ	2.50	0.20	2.55	0.19	2.52	2.214	2.844
ρ_r	0.76	0.05	0.73	0.05	0.72	0.642	0.804
r_π	1.50	0.40	1.39	0.38	1.50	0.859	2.160
r_y	0.50	0.10	0.51	0.10	0.53	0.357	0.683

ρ_g	0. 68	0.14	0.13	0.02	0.13	0.099	0.164
g_y	0. 50	0.20	1.41	0.17	1.39	1.140	1.668
ρ_τ	0. 73	0.05	0.63	0.05	0.63	0.550	0.712
τ_y	0. 63	0.20	0.69	0.20	0.69	0.368	1.013
g_b	0. 40	0.02	0.36	0.02	0.36	0.326	0.393
τ_b	0. 40	0.02	0.40	0.02	0.40	0.371	0.433
ξ	0. 75	0.05	0.74	0.05	0.74	0.657	0.819
ρ_a	0. 50	0.15	0.50	0.18	0.51	0.248	0.739
ρ_{c^*}	0. 80	0.05	0.84	0.03	0.84	0.787	0.899
ϵ_t^r	0. 30	2.00	0.28	0.03	0.29	0.239	0.350
ϵ_t^g	3. 30	4.00	3.34	0.38	3.45	2.802	4.104
ϵ_t^f	1. 80	4.00	1.67	0.19	1.72	1.382	2.032

The first four parameters in Table 2, namely the Calvo parameter, the inverse elasticity of labour supply, the inverse elasticity of substitution in consumption and the interest rate smoothing parameter are borrowed from two studies on the Hungarian economy done by Jakab and Kónya (2016) and Jakab and Világi (2008). The prior mean and standard deviation of the technology parameter are also obtained from these same studies. The Calvo parameter with its value of 0.93 is especially high compared to the literature standard, which is set between 0.5 and 0.75. The Taylor parameters are set according to the industry standard. We borrow the prior mean of the parameter representing the portion of backward looking firms from Çebi (2013) and set it 0.05 higher at 0.75. The prior means of the parameters representing the fiscal responses to the output gap are borrowed from Algozhina (2012), who estimates a DSGE model for the Hungarian economy. Lastly, we obtain the prior means and standard deviations of the errors from the studies referenced in this paragraph. We slightly modify these priors, so they better fit the underlying data. After calibrating the selected parameters and selecting priors for the remainder we proceeded to estimate the model.

Table 2 also presents the parameter estimation results, namely the estimated posterior mode, standard deviation, posterior mean and the 90% confidence bands. We use seasonally adjusted real GDP, CPI inflation, the three-month T-bill rate, government spending to GDP ratio and tax to GDP ratio as observable variables. We obtained the data for Hungary from the International Financial Statistics database of the

International Monetary Fund. The data covers the period of 2010Q1:2018Q4. We detrend the data if needed, either by taking differences or using the Hodrick-Prescott filter. We estimate the parameters and the impulse response functions using Dynare for Matlab.

4 Impulse response functions

In this subchapter we present the Bayesian impulse response functions with 90% confidence bands. There are three shocks in the model, namely the government spending shock, the tax shock, and the interest rate shock. Five endogenous variables react to these shocks. These endogenous variables are output, inflation, the nominal interest rate, government spending and tax. We begin with analyzing the effects of the government spending shock on the economy.

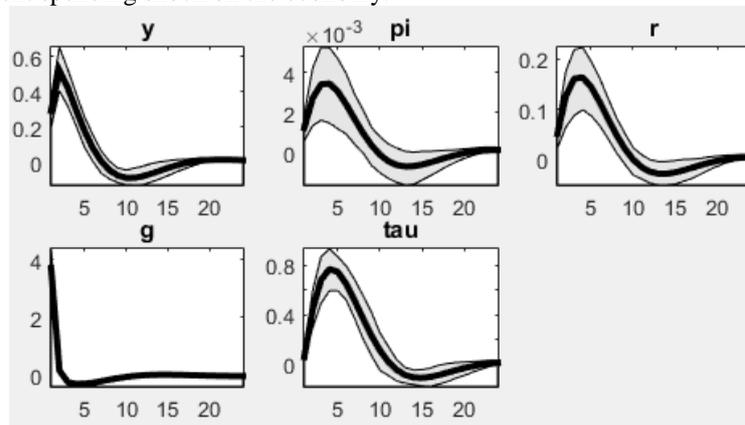


Fig. 1. Government spending shock

Firstly, the effects of an unexpected increase in government spending on the economy are presented on figure 11. As a result of an unexpected increase in government spending both output and inflation rise. The rise in output is expected, but at first glance the rise in inflation might seem contradictory. Government spending should result in a decrease in inflation via marginal cost. In our case, however, the increase in output is higher than government spending's effect on the marginal cost of firms. This explains why inflation rises. Because inflation is higher, the monetary authority reacts to it by raising the interest rate. Debt also reacts to these factors and increases, because interest rates are higher and government spending is increased. Because of this the government needs to stabilize debt levels. It raises taxes to do so. This results in a unique situation, when the expansionary fiscal policy – which means increased government spending – is accompanied by restrictive monetary policy and increased taxation. Based on figure 11 we can conclude that the effects of the shocks are statistically significant, and the variables return to their respective steady states.

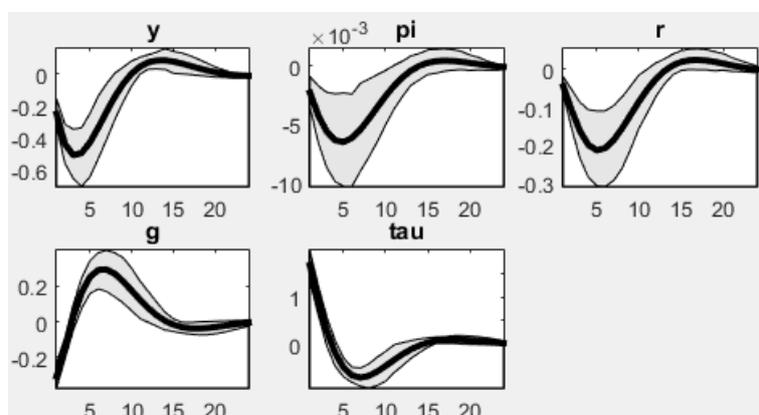


Fig. 2. Tax shock

Secondly, the effects of an unexpected increase in taxes are presented on figure 12. As a result of an unexpected increase in taxes output decreases. Taxes affect the economy via two channels. Through the first channel income taxes reduce disposable income and lead to a decrease in output. Through the second channel an increase in payroll taxes leads to an increase in the marginal cost of firms, thereby reducing aggregate supply. Furthermore, an increase in payroll taxes also increases prices, again via the marginal cost. We, however, cannot see an increase in inflation on figure 12. On the contrary, inflation decreases. At the beginning taxes increase and government spending falls, which leads to a decrease in debt. After the government debt was reduced to the appropriate level, taxes return to their steady state and government spending increases, before returning to its own steady state value. Since government spending decreases inflation via marginal cost, it seems that the effects of spending outweigh the effects of taxation. The monetary authority reacts to the decrease in inflation by conducting an expansionary monetary policy and thus it decreases the interest rate to stimulate the economy. Based on figure 12 we can conclude that the effects of the shocks are statistically significant, and the variables return to their respective steady states.

Thirdly, the effects of an unexpected increase in the nominal interest rate are presented on figure 14. As a result of an unexpected nominal interest rate shock output decreases along with inflation. The interest paid on government bonds is higher, which leads to higher levels of government indebtedness. To stabilize debt the government implements restrictive fiscal policy, resulting in government spending cuts and an increase in taxes. This kind of fiscal policy has two effects. Firstly, lower government spending further reduces output. Furthermore, larger taxes decrease the purchasing power of households, further decreasing demand. Secondly, these government measures affect the behavior of firms via marginal cost. As these firms now face increased costs, they raise prices and households need to bear the cost burden. This leads to an increase in inflation, which we can see on figure 14. It seems that the decrease in inflation was offset by the fiscal policy reaction, which results in an increase in the price level. According to these reactions both the monetary and fiscal authorities

react the same way to an unexpected nominal interest rate shock. Both implement restrictive policies. Based on figure 14 we can conclude that the effects of the shocks are statistically significant, and the variables return to their respective steady states.

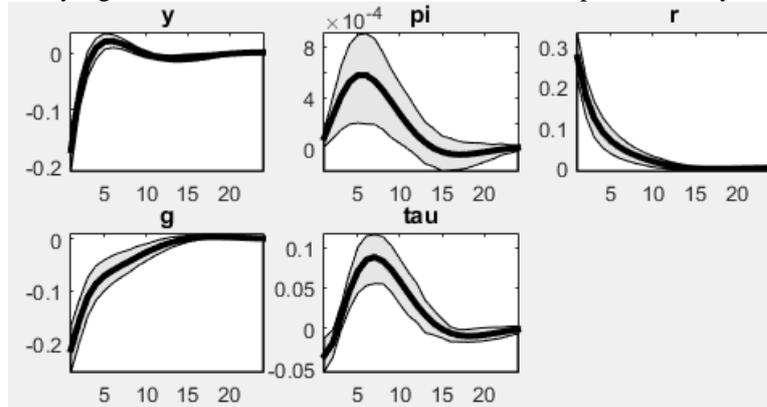


Fig. 14. Interest rate shock

5 Conclusion

In this study we calibrate and estimate the parameters of a New Keynesian small open economy dynamic stochastic general equilibrium model. We get similar results as Çebi (2013), who estimated a DSGE model for Turkey. We analyze the results using impulse response functions and focus our attention on the type of fiscal policy and monetary policy implemented by the authorities. Sometimes restrictive fiscal policy is accompanied by restrictive monetary policy. At other times the policies adopted by the fiscal and monetary authorities are different from each other. For example, in the case of the government spending shock expansionary fiscal policy is accompanied by restrictive monetary policy.

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Iran's Position as an Oil Power

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Abstract. Oil extraction and export is the most crucial sector of the Islamic Republic of Iran's economy. Iran is one of the countries with the largest oil reserves, and revenues from its sale are the most important source of funding. However, this sector is sensitive to external factors and reacts sharply to developments in foreign markets. The change in the value orientation of Iran's foreign policy after the evolution in 1979 has resulted in a period of instability that has had a significant impact on Iran's oil industry. In this paper, we will try to describe the most significant factors that affect the oil industry in Iran. This paper considers mainly external determinants such as sanctions and its effectiveness, oil price volatility and political and economic relations between Iran and international community. At the end of this paper author examines the perspectives in the Iranian economy in the following decades. The work also deals with the main economic issues that the administration of the newly elected president Ebrahim Raisi will face.

Keywords: Oil Industry, Islamic Republic of Iran, Sanctions, Oil Exports

JEL classification: F51, N45, N55

1 Introduction

In terms of the commodity composition of Iran's GDP, oil production is currently one of the key sectors of the Iranian economy. Iran has one of the most diverse economies in the Middle East region. However, the oil revenue still generate 30% of the government revenues (Azadi – Dehghanpour – Sohrabi – Madani, 2016). The beginnings of the Iranian oil industry date back to the beginning of the 20th century, when the country's first oil reserves were discovered (Howard, 2007). Thus, a number of world powers turned their attention to the former Persian Empire. During the Pahlavi dynasty era between 1925 and 1979, the Iranian economy relied heavily on western countries, especially the United States. This has also greatly affected the Iranian oil industry. However, the Iranian Islamic Revolution of 1979 represented a significant

change in Iran's oil trade and export orientation of this country. The application of elements of Shiite Islam has manifested itself not only in the domestic sphere but also in the relations between Iran and other members of the international community. The clergy, led by **Ayatollah Ruollah Khomeini**, sturdily criticized the monarchy's excessive attachment to western powers, especially seen in the oil industry. The change in the value orientation of Iran's foreign policy has resulted in a period of instability that has had a significant impact on Iran's oil industry. In the following section, we intend to explain the specific factors that have posed a major impact on the development of Iran's position in world oil trade. In the final part of this paper, we also analyze the perspective of further development of this crucial sector of the Iranian economy and we offer our own views on the future of the Iranian economy.

2 Research goals and methodology

The primary aim of this paper is to evaluate the analysis of the key determinants influencing Iranian petroleum industry since the Iranian Islamic Revolution of 1979. The government of the clergy has brought several changes to Iranian society, especially in the socioeconomic field. This paper also presents short prediction of the possible developments in the Iranian economy and related challenges.

To examine such a complex issue, relevant references are needed. As for bibliography, we found inspiration in the papers written mainly by foreign authors. Important information could be found in the Kevjn Lim's paper. **Kevjn Lim** is a senior risk advisor for the Middle East and North Africa at IHS Markit Country Risk, where he also runs the lead for Iran.

This paper was also inspired by publications by professors **Murat Aslan, H. Kürşad Aslan** and **Yasir Rashid**. They have extensive experience in the field of international political relations and the economy of Asian countries. Information related to the impact of oil price volatility on Iranian economy was found in the publications written by **Amir Mansour Tehranchian** and **Mohammad Abdi Seyyedkolae** from the Department of Economics of University of Mazandaran in Iran.

Most of sources are publications written by western authors such as **Roger Howard** and **Benjamin Smith**. Their research is focused on Iranian oil industry and Iranian economy. Furthermore, there was found useful information in the works written by **Pooya Azadi, Hassan Deghanpour, Mehran Sohrabi** and **Kaveh Madani**.

The work by domestic authors **Stanislav Mráz, Ludmila Lipková** and **Katarína Brocková** regarding the effectiveness of sanctions on Iranian economy was also very useful and beneficial. The issues regarding specific implication of sanctions on the oil market are also mentioned in the paper by authors from the King Abdullah Petroleum Studies and Research Center – **Fakhri Hasanov, Emre Hatipoglu, Carlo Andrea Bollino** and **Brian Efird**.

Report of research economists **Mahdi Ghodsi, Vasily Astrov** and **Richard Grieveson** and scientific director of the Vienna Institute for International Economic Studies - **Robert Stehrer** was also used during the research. The work is inspired by

online publications written by authors such as **Samantha Gross, Brett Sudetic, Omid Shokri** and **Maziar Motamedi**.

Based on the defined goal, the work can be described as qualitative research from the methodological point of view. Several methodological procedures and methods such as analysis method or synthesis method are used in the processing of the issue, so that the main goal is met and the interpretation of the conclusions of this work is as credible as possible and reflects the real state of the researched issues. The contribution of this paper lies in obtaining information from complex issues and their accumulation in a comprehensive document, applicable for further research.

3 The main factors influencing Iran's position in the world oil trade

The Iranian revolution has caused several changes in the Iranian economy. The rule of cleric-dominated state caused the massive capital fled the country. Public enterprises came to the fore and the private sector was pushed out. Some educated people and experts resolved to leave the country and many non-experts came to the management of the Iranian enterprises. The changes in the country's governance also affected the oil industry (Karbassian, 2000). Subsequently, the article will define the basic factors that have influenced and continue to influence Iran's oil trade. From our point of view, these aspects are key, which is why we have turned our attention to them.

3.1 Sanctions imposed by western countries

According to the findings, one of the most significant factors affecting the Iran's economy since the Revolution of 1979, has been the relationship between Iran and the western countries. From this point of view, sanctions from advanced economies are often inflicted. This legitimate means of public international law has been for the most part the result of a significant contradiction between the policy of the Islamic clergy and the perception of the world by the liberal democracy of western countries. In the case of Iran, sanctions of a collective and individual nature can be defined. **Ali Feghe Majidi** and **Zahra Zarouni** point out, that the human rights violation, the nuclear program and supporting terrorism can be identified as the main motives for the introduction of economic sanctions against Iran (Majidi – Zarouni, 2020). The United Nations and the European Union have resorted to this remedy for a number of reasons. The most significant individual sanctions were imposed on Iran mainly by the United States (Mráz – Lipková – Brocková, 2016). From our perspective, sanctions imposed on the whole industry, or just a specific sector, are not an effective enforcement tool. They often harm the domestic population and, instead of changing the attitude of the government and its representatives, they only cause a decline in the living standards of the domestic population. From this point of view, dialogue must be pursued first and foremost. In some cases, however, such negotiations are unsuccessful, and it is

necessary to look for other ways to force the state to respect the fundamental principles of the international community - one such solution is offered in the form of sanctions.

The sanctions system has long had a major impact on all spheres of Iranian economy. However, oil industry is specific in this respect. Its peculiarity lies primarily in its dependence on foreign capital and investment. Restrictions on oil extraction and exports have an enormous impact on several other macroeconomic indicators in the country. This is visible especially in influencing the national income or in the complex problem of inflation. Decreased oil revenues may also affect other sectors of the economy and their production (Aslan – Aslan – Rashid, 2020).

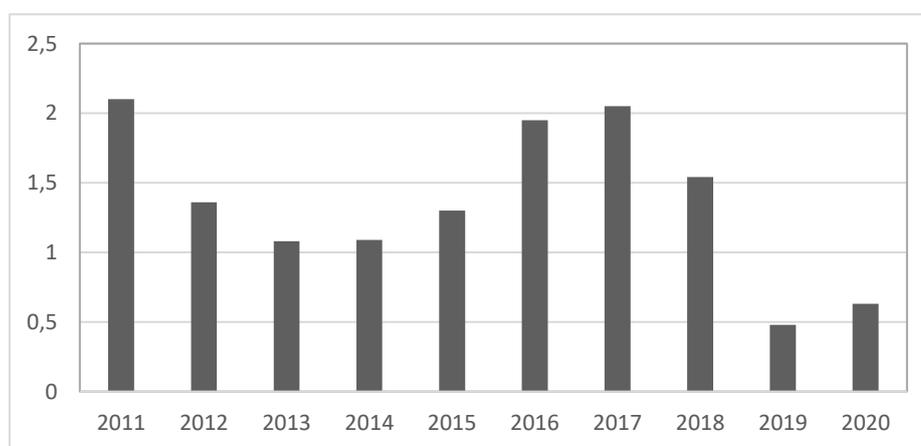


Fig. 1. Iranian oil exports in millions of barrels per day.

The graph above shows Iranian oil exports in millions of barrels per day in past 10 years. Following the imposition of US sanctions on the Iranian oil industry in 2011, a significant drop in Iranian oil exports can be seen. The recovery can be seen after 2015, when the sanctions following the nuclear deal were lifted. A further decline in exports is recorded after 2018, when the United States withdrew from The Joint Comprehensive Plan of Action (JCPOA). It's frankly important to take into the considerations also price volatility and impact of changes in global oil prices on Iranian oil exports. However according to data, it is clear to what extent sanctions have affected Iranian exports in the previous decade (Federal Reserve Economic Data, 2021). To support this thesis, it's important take into the consideration data from U.S. Energy Information Administration. According to this data, Iran crude oil exports declined by more than 1,2 thousand barrels per day between 2011 and 2014. The main cause of this decline can be considered the replacement of Iranian oil imports. The countries of the European Union, South Africa, China and other Asian countries decided to replace Iranian imports with imports from other countries such as Saudi Arabia, Nigeria and

Angola, which obviously resulted in a reduction in Iran's oil trade (U.S. Energy Information Administration, 2015).

3.2 Price volatility and relations with non-western countries

However, we would like to mention the fact that the sanctions imposed by the western countries, are most significant factor influencing Iran's position in world oil trade, but not the only one. The oil revenues play a significant role in the economic terms of the oil exporting countries. The volatility of raw materials prices and its impact on the economic growth is an important issue confronting several world economies, including Iran (Tehranchian – Seyyedkolae, 2017). An example is the situation from the 80s. Advanced economies responded to oil crises in 70s by discovering new sources of oil, such as resources in North Sea, Alaska, or Gulf of Mexico. Oil exported by non-OPEC countries entered the market. As a result of growing supply and shrinking demand, oil prices declined 40 percent between 1981 and 1985. This situation has had a significant negative impact on oil revenue resources for the entire Middle East (Gross, 2019). Specific numbers can also be given as evidence. In 1983, the price of oil on world markets remained at \$ 30 per barrel, and by 1986 it fell to about \$ 10 per barrel (Trading Economics, 2021). Over the same period, Iran's oil exports fell from 1,750 barrels per day in 1983 to below 1,500 barrels per day (CEIC Data, 2021).

One of the key determinants affecting Iran's oil industry can be found in strengthening trade relations with non-western countries. The attitude of western countries toward Iran can be used by key partners in the Iranian economy, Russia and especially China. China is Iran's largest trading partner. More than half of Iran's exports to the country is crude oil. Although China backed sanctions, it remains a major Iranian partner and a major source of investment and capital. Moreover, friendly relations between those two countries are likely to develop even more, thanks to The New Silk Road Project (Lim, 2021). As **Brett Sudetic** and **Omid Shokri** examine in their article, China attempts to find the sharpest ways to reach Iranian oil, despite the sanctions imposed on the Iranian oil industry by the United States. The main goal is to strengthen China's regional and geopolitical position, but also to undermine the US position in the Middle East (Sudetic – Shokri, 2021).

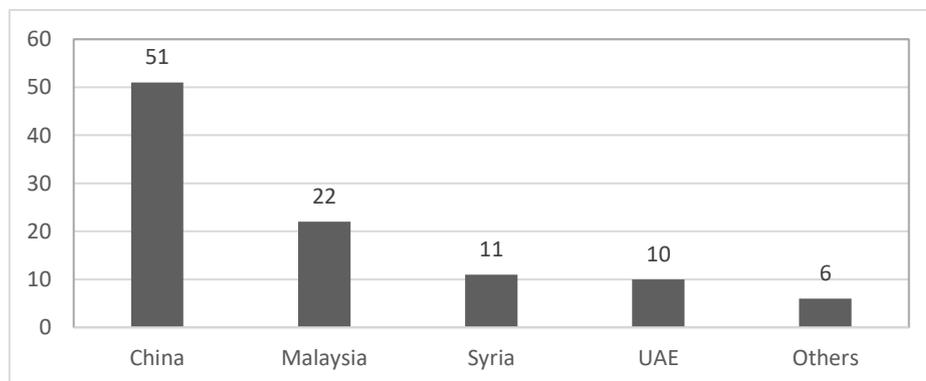


Fig. 2 Territorial structure of Iranian oil exports in 2020.

The graph deals with the territorial structure of Iranian oil exports in 2020. In this case, China has an important position, to which up to 51% of Iranian oil is exported (U.S. Energy Information Administration, 2021). The largest volume of Iranian crude-oil since 2008 is exported to the Asian countries such as China, South Korea, UAE and Pacific region. More than 590 thousand barrels per day were exported from Iran to this region in 2019. European union and other European countries have been the second largest importer of Iranian crude-oil, with the volume more than 59 thousand barrels/day in 2019 (Statista, 2021). We are of the opinion, that China's attention to the Middle East region will grow stronger in the coming decades. In our opinion, the American withdrawal from its positions in this region, which is visible in Afghanistan, for instance, will lead to a deepening of relations between China and the countries of the Middle East mainly in economic field.

4 Future perspectives

The victory of **Ebrahim Raisi** in the Iranian presidential election in 2021 launched a public debate on the future direction of the Islamic Republic of Iran. The main task for this ultra-conservative successor of former president Rouhani will be, in addition to the fight against the coronavirus pandemic, also the stabilization of the Iranian economy. To ensure economic stability, better and more effective diplomatic and foreign policy to a removal of the sanctions will be needed. Furthermore, there are also another crucial issues such as high inflation rate, lack of financial stability, transparency of domestic policies or unemployment and devaluation of Iranian currency (Motamedi, 2021). Strikes and mass dissatisfaction of workers with working conditions were one of the main triggers of the Iranian Revolution in 1979. A healthy economy and working-class satisfaction are therefore extremely important for the proper functioning of the state (Smith, 2007). An important task for Ebrahim Raisi will not only be the continuation of favorable trade and political relations with China and the other Asian region, but especially the improvement of communication with Western countries. Investment from the European Union and the United States could be a major source of foreign investment that Iran needs. A new nuclear program agreement could eliminate sanctions and help revive Iran's oil industry as well as other sectors of the economy. However, the ever-present skepticism and antagonism of the West among the Iranian public still undermines this notion. Unlike the reformists and moderates, president Ebrahim Raisi has no specific plan how to attract FDI from the Western countries. As a result of this policy, country will presumably become economically more dependent on Russian federation and China.

However, there are several longer-term issues that the new Iranian leadership will have to take into account. Nevertheless, there is also environmental factor. Many countries have committed to carbon neutrality. Reducing the carbon dioxide content in the air can thus, have a significant impact on the entire oil industry. Studies show that the legislation acceptable for environmental protection will result in limitation of

maximum annual growth rate of global oil demand to 0.6% through 2030 (Azadi – Dehghanpour – Sohrabi – Madani, 2016). From our point of view, therefore, the transformation and diversification of Iranian economy is essential in the long term. The perspective lies primarily in strengthening the services sector and Iranian tourism. Moreover, there are also other (non-oil) sectors, that have not yet received enough investment, in particular the construction sector. Therefore, in the coming decades it will be necessary to concentrate not only on the new search for new crude oil resources, but especially on the upliftment of non-oil sectors. This is the only way how to ensure the sustainable economic growth in Iran.

5 Conclusion

To conclusion, the political change that hit Iran between 1978 and 1979 was also reflected in the Iranian economy. The Islamic Republic of Iran faces several challenges, most of which linked to international isolation, caused by economic sanctions imposed by western countries. The key for the Iranian economy is the oil sector, which plays an important role in Iran's GDP. The paper defines 3 determinants influencing the Iranian oil industry. Firstly, it is the sanctions imposed by the United States, but also by other European countries, that can be the most important factor influencing the Iranian oil industry. The results show that the sanctions imposed for alleged support for terrorism or for the continuation of the nuclear program have had a major impact on reducing Iranian oil production and exports. During the period of sanctions, many countries tried to find alternatives to meet their demand for oil, which had an impact on the Iranian oil industry.

The second factor affecting Iran's oil exports is the volatility of prices on the world oil market. Potential new oil deposits and expanding oil supply on the world market could weaken Iran's position. According to the data, there was such a decline in Iranian oil exports during the 1980s, and this situation may be repeated in the future.

To ensure the improvement of standard of living, constructive relationship with China, Russia and West will be needed. It is the rhetoric of the ruling clergy in relation to foreign countries that will be a most crucial factor in this regard. Lots of data suggest that much of Iran's oil flows to Asia and the Pacific. It is the consolidation of its trade relations with China and other countries in the region that will be a key task for the Iranian government in the coming decades.

The current President of Iran, Ebrahim Raisi, faces a difficult task - to ensure a stable economic situation in the country. The biggest problems for it in the short term are inflation, unemployment, and the devaluation of the national currency. However, reforms with a longer-term effect will be more important. Iran's economy and oil industry are facing significant changes in the coming decades. The Iranian government is expected to respond to current, especially environmental issues by diversifying its economy. The ability to adapt to climate change and new trends in world trade will be a crucial factor for the Iranian economy.

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Fintech and Big tech as the new credit provider

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Abstract. The change that new technologies will bring to the banking sector can take many forms. Some of these can be already seen in the field of payments, various types of investments but also loans for retail clients and small companies. On one hand, current banks could continue to dominate by providing additional benefits to customers through improvements enabled by technological innovation. On the other hand, current banks may find themselves in a customer battle with new, more agile market participants, who are faster in adopting innovations that meet clients' needs. These developments have the potential to make markets more diverse, competitive, and efficient, but also may be a threat for the financial stability. In this paper, we aim to examine growth in Fintech and Big tech loans during recent years around the world. Secondly, we explore the relationship between flows of alternative credit and gross domestic product. Analysis suggests, that there may be polynomial relationship with declining rate past certain point.

Keywords: digital innovation, Fintech, Big tech, loans, technology

JEL classification: G10, G21

1 Introduction

Since the global financial crisis, banking sector has been affected by low interest rates and constantly increasing regulation. These and many more factors, such as technological advancement, allowed new participants to join financial sector with aim to address customer needs more effectively. While before the financial crisis the largest banks were mainly in Europe and the USA, today the banking sector is beginning to be dominated by Chinese banks and other start-ups, which have seen enormous growth in recent years.

The Financial Stability Board (2019) defines Fintech as “a technology-enabled financial innovation that can result in new business models, applications, processes or products with a significant impact on financial markets and financial services

institutions. These companies have different market conditions, regulation but also growth rate. Diversity can also be seen in individual countries. In addition, individual countries also seem to have differences in their attitude and support for these institutions. The most important development of Fintech companies can be seen in the area of mobile payments, alternative financing such as crowdfunding or automatic comparison platforms, which are used mainly for lending to small and medium-sized enterprises, but also to individuals.

In recent years, established players in the technology market (Big tech), such as Amazon or Apple have also gradually become more and more integrated into the financial services markets. Thanks to their existing business models, they have a great advantage over traditional credit institutions. Unlike smaller Fintech companies, Big tech can compete with banks on a larger scale, using large amounts of data and technology to process them. These technologies are either not owned by traditional banks or they are not yet able to use them so well. However, the entry of these giants can bring increased efficiency and availability of advanced financial products.

While the technical innovations that trigger changes in the banking sector are present for a long time, the current pace of Fintech innovation and adoption is creating an environment, in which disruption may happen more quickly than in the past, forcing traditional banks to go the distance in attempt to maintain customer relationships and market share. Some of the examples of technological innovations in the past may be automatic teller machines, internet banking or mobile point of sale devices.

In this paper, we will try to describe the state of Fintech and Big tech loans around the world and discuss their potential as a disrupting power in current banking sector. Also, we would like to explore the relationship between alternative loans and gross domestic product in examined countries.

2 Review of authors

Emergence and diffusion of new technologies in financial sector has been one of most discussed topics during recent years. Introduction of cryptocurrencies as new payment method or crowdfunding as new way of raising capital were just few examples, how Fintech companies change financial wellbeing. However, predicting what the future holds for these new players still needs some further research.

Christian Haddad and Lars Hornuf (2018) investigated economics and technological determinants leading entrepreneurs to establish new Fintech companies around the world. They find, that well-developed countries with more available venture capital are more likely to be the place of new found financial start-ups. Furthermore, the number of secure Internet servers, mobile telephone subscriptions, and the available labor force has a positive impact on the development of this new market segment. Finally, the more difficult it is for companies to access loans, the higher is the number of Fintech start-ups in a country. Altogether, study points out that active policies in the countries may influence the emergence of this new sector of financial intermediaries.

The empirical study done by Stijn Claessens et. al. (2018) looks closer at Fintech credit development around the world. It suggests, that the economy's overall

development, the competitiveness of the economy's formal banking sector, and the strength of its regulatory environment play important role in this relationship. Despite its fast expansion, Fintech credit remains relatively small in most economies. It is, however, considerably larger in China, the United States and the United Kingdom, as well as in specific market segments.

Big tech companies often start with payments. Thereafter, some expand into the provision of credit, insurance, and savings and investment products, either directly or in cooperation with financial institution partners. If we look closer at Big tech credit, Jon Frost, Leonardo Gambarota, Yi Huang, Hyun Song Shin and Pablo Zbinden (2019) show, that Big tech firms lend more in countries with less competitive banking sectors and less stringent regulation. They found, that the drivers of Big tech credit are similar to those of Fintech credit (economic activity, financial regulation and competitiveness) and also showed evidence that Big tech lenders may have an information advantage in credit scoring relative to a traditional credit bureau.

According to Raghavendra Rau (2020), the introduction of explicit legal regulation appears to significantly increase crowdfunding volume. Regulatory clarity, by setting explicit regulatory guidelines, is likely to have a strong positive impact on financial sector development.

Cross-country panel regressions in study by Giulio Cornelli, Jon Frost, Leonardo Gambacorta, Raghavendra Rau, Robert Wardrop and Tania Ziegler (2020) show, that alternative credit is more developed in countries with higher GDP per capita (at a declining rate), where banking sector mark-ups are higher and where banking regulation is less stringent. Fintech credit is larger where there are fewer bank branches per capita. They also found, that Fintech and big tech credit are more developed where the ease of doing business is greater, investor protection disclosure and the efficiency of the judicial system are more advanced, the bank credit to deposit ratio is lower and where bond and equity markets are more developed.

Majid Bazarbash and Kimberly Beaton (2020) use data for 109 countries from 2015 to 2017 to study the relationship between Fintech credit to businesses and consumers and various aspects of financial development. Marketplace lending to consumers grows in countries where financial depth declines highlighting the role of Fintech credit in filling the credit gap by traditional lenders. This result is particularly strong in low-income countries. In the business segment, marketplace lending expands where financial efficiency declines. Findings show that low-income countries take advantage of the Fintech credit opportunity in the consumer segment but face important challenges in the business segment.

We will now proceed to the aim and methodology of our paper.

3 Aim and methodology

The main aim of this paper is to describe development of Fintech and Big tech credit around the world. Secondly, we would like to look closer on the relationship between these types of alternative credit and GDP. Countries with higher GDP per capita are expected to attract more capital and therefore develop and use the newest technologies

to meet the financial needs of customers. However, these new technologies may also be relevant for countries with less developed bank system, because of the transaction cost reduction, information asymmetries but also just because they are easier for customers to use.

To address these aims, we use the same data of Fintech and Big tech credit as G Cornelli, J Frost, L Gambacorta, R Rau, R Wardrop and T Ziegler (2020). Flow of Fintech credit represents volume of new lending during given year in selected countries. Likewise, flow of Big tech credit represents volume of this type of lending. Dataset consists of 102 countries for seven years period from 2013 to 2019. As other source of data, we use available data from World Bank. Specifically, we use gross domestic product divided by midyear population and also total population of selected countries. Since the original dataset of Fintech and Big tech lending contains only data between years 2013 and 2019, we are structuring our analysis in this time period.

Description of mentioned data can be seen below in table 1. In our analysis, we expect, that countries with higher GDP per capita experience more flows of alternative credit. To compare alternative credit on the same scale, we divide it by total population of the country in given year.

Table 1. Description of data used in analysis

Variable	Description	Source
Fintech credit	Flow of new lending over a calendar year	Bank for international settlements
Big tech credit	Flow of new lending over a calendar year	Bank for international settlements
Domestic credit	Total domestic credit by financial sector	Bank for international settlement
GDP per capita	Gross domestic product divided by midyear population.	World bank
Total population	Midyear estimates of total population in the country	World bank

4 Results and discussion

Although Fintech and Big tech may seem similar, there are several important differences between them. Fintech loans started primarily on decentralized platforms,

where the demand for loans from retail clients or small and medium-sized enterprises met the supply of loans primarily from individual investors. These platforms were thriving mainly in an environment of higher interest rates and the unavailability of loans from traditional banks. The advantage of this method of lending is the reduction of asymmetric information and transaction costs. Over time, some platforms have shifted to financing loans from institutional investors and not just individuals.

Large technology companies, on the other hand, have different business lines, of which loans represent only one (often not very big) part, while their main business activity is usually non-financial in nature. Their business model leverages three main factors. First, the data they already have on consumers are helping in understanding the customer needs better. Secondly, they can use extensive user data, which are often obtained from non-financial activities, to alleviate problems with asymmetric information and lastly, they rely on strong networks effects from leveraging their large consumer base. Big volumes of information however, whereas allowing Big tech companies to effectively measure loan quality, can also cause price discrimination and disrupt competition in the banking sector.

Fig. 1. Total flow of alternative credit in given year

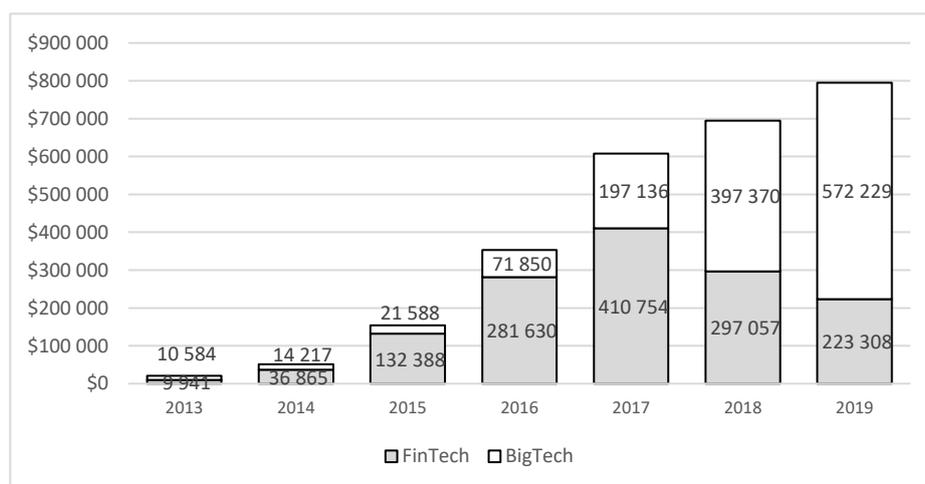
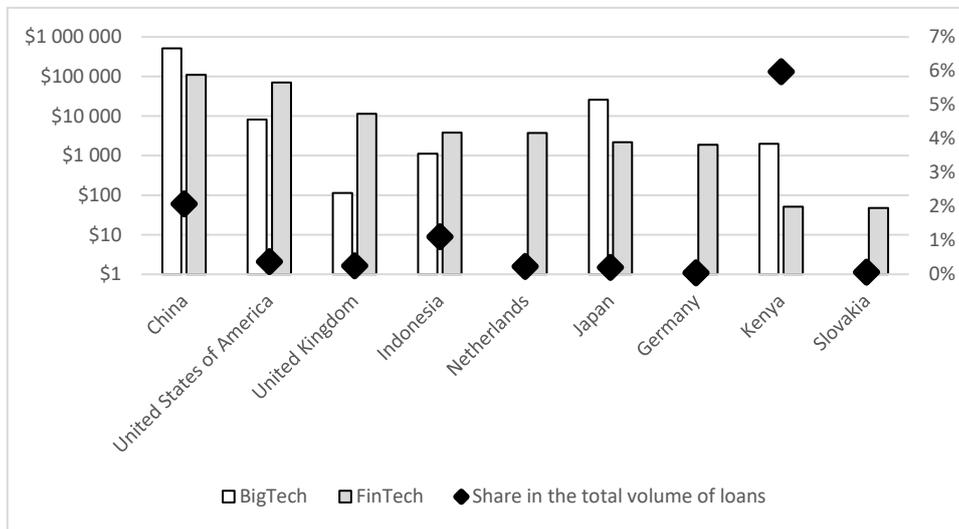


Figure 1. shows the development of new volumes of alternative loans on an annual basis in millions of dollars. Fintech loans recorded the largest increases globally around 2017, but since then the curve has been breaking and gradually declining. This may be because many of Fintech's platforms, such as the Lending Club in the US, are starting to apply for a bank license and becoming banks or being bought by banks. The opposite trend can be seen when tracking loans from Big tech companies. In 2019, the increase in Fintech loans accounted for only 39% of the size of the increase in loans from large non-financial corporations. The main reason for this is likely the significant development of credit products in the markets of China and Japan.

The distribution of the new volume of alternative loans in selected countries can be seen in Figure 2. The primary axis (left) is in logarithmic form, as loans in some countries are orders of magnitude higher than in others. By far the largest Fintech but also the Big tech market in this case is China. The companies providing these loans are primarily Ant Group, We Bank or Du Xiaoman.

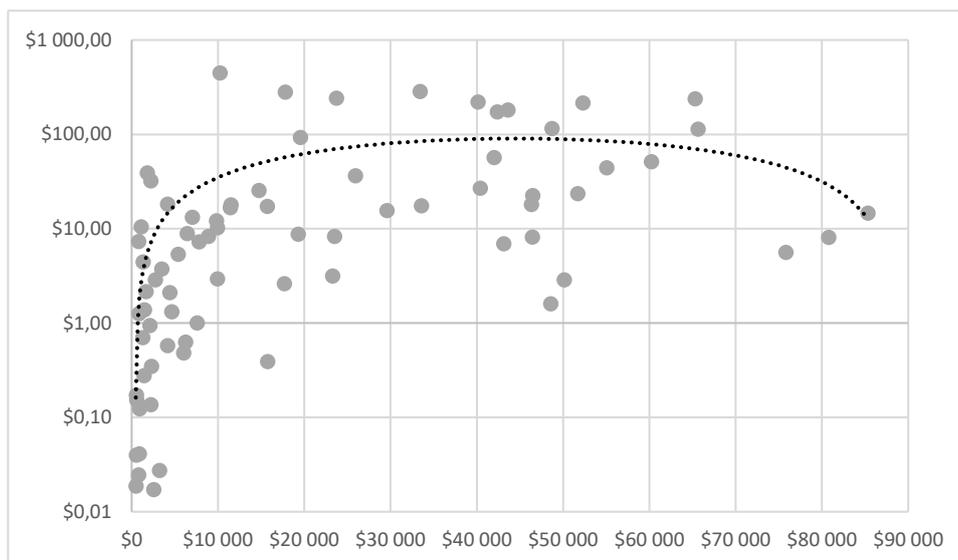
If we look at the market of the European Union without the United Kingdom, we can see that the market for Big tech loans is practically non-existent. The main reason will probably be high regulation and a strong traditional banking market. We have also added data from Slovakia to the chart, where we can see that there is a Fintech loan market slowly emerging.

Fig. 2. Flow of Fintech and Big tech credit within selected countries in 2019



On the secondary axis (right) we can see the ratio of new alternative loans to the total volume of loans in the country in year 2018. This value is below 1% in almost all countries shown. The exceptions are China, Indonesia and especially Kenya - where this ratio is estimated to be more than 5%. As expected, ratio of new alternative loans to the total volume is higher in less developed countries and vice versa. Even though this trend is rising all around the world, it may differ vastly in various countries and it will be exciting to monitor its next development.

Fig. 3. Visualization of gross domestic product per capita and flow of alternative credit in sample of 100 countries in 2019



To visualize the relationship between flow of alternative credit and gross domestic product of countries, we divided these two variables by total population and plotted this dataset on scatter plot. Data used in this analysis are from 2019 and represent 85 countries. Axis Y shows flow of alternative credit per capita on logarithmic scale. Axis X shows gross domestic product per capita. Data points represent individual country and its position in the graph.

If we look at Figure 3., we can see that with higher gross domestic product per capita, countries tend to experience bigger flows of alternative credit per capita. In certain level, however, we can see that this trend starts to decline, suggesting polynomial shape of function. This conclusion is also mentioned in paper by Giulio Cornelli, Jon Frost, Leonardo Gambacorta, Raghavendra Rau, Robert Wardrop and Tania Ziegler (2020).

Some of the other variables connected to the development of these new types of loans that may be relevant for further research are for example strictness of bank regulation or overall bank sector competitiveness.

The more difficult it is for a start-up to enter the banking market, whether due to regulations, market saturation or even, for example, low interest margins, slower the growth of alternative loans in the given countries may be expected. Some of these assumptions may be even relevant for the discussion about the position of Fintech and Big tech market in Europe.

Given how young the industry is, it is too early to properly evaluate impact of these alternative loans on lenders and borrowers, let alone on financial stability and the whole

economy. Therefore, it is important to explore these causalities in more depth and try to better understand drivers of growth in individual countries.

5 Conclusion

Financial technologies are gradually starting to disrupt the traditional banking market and are likely to have a significant say in the upcoming years. Fintech and Big tech players are beginning to acquire several domains in the financial markets, such as payments, savings, investments and, last but not least, loans to retail clients and also to smaller companies. Various forms of these new companies may definitely change the banking market as we know it today. On the one hand, traditional banks can adapt to new technologies and not allow new market players to break through permanently. On the other hand, new start-up companies can replace banks thanks to their speed of adoption of new business models and technologies.

In our analysis, we focused on the development of Fintech and Big tech loans worldwide. We have shown, that the volume of these loans is rising every year and big non-financial players like Apple or Amazon are getting the word out. On the other hand, flow of Fintech loans is slowly starting to decline, which may be due to the fact, that several Fintech companies are obtaining bank licences, banks are catching up in technology or buying simply acquiring them because of their functionalities and potential.

The development of these loans is recorded primarily in China, America, the United Kingdom, but also in Japan, where the big tech market is developing very significantly. If we look at the European market, we can see the opposite case here as in Japan - since Big tech loans are not yet present here, probably thanks to strong banking regulation. The total share of these types of loans in the total amount of loans in the country so far is only around 1%, with the exception of some countries, where the bank loan market is not as saturated as in more developed countries.

In examining the relationship between these loans and the development of countries by gross domestic product per capita, the analysis has showed a polynomial relationship, where loans to a certain point of GDP increase and then the curve begins to rotate. We therefore came to conclusion, that countries with higher GDP per capita seems to have higher flows of alternative capital per capita than countries with less GDP per capita and the objectives of this paper have been met. Our findings may also indicate, that alternative loans have potential to grow mainly in low or middle-income countries, especially where banking sector is not properly developed or is experiencing higher interest rates on traditional loans.

Our analysis is just a peak of iceberg in this important topic, however we hope that the area of financial technologies used in banking sector will get more research attention in years to come.

Acknowledgement

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Use of Scanner Data in Measuring the Consumer Price Index in the Conditions of the Slovak Republic

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Abstract. The compilation of the Consumer Price Index (CPI) is, in the conditions of the Slovak Republic, based on the fixed consumer basket. Only the lockdown during pandemics showed us how a fixed basket can very quickly become irrelevant due to a rapidly changing model of consumer behaviour. The changeover from traditional data collection to the usage of data from scanners practically means the passing from static universe of selected sorts of goods to the dynamic universe of all goods consumed. While classical bilateral indices may be appropriate for a fixed basket, the transition to a dynamic approach raises the question of whether traditionally used methods are still valid. Our goal is to publish high quality index and therefore it is necessary to bear in mind that the index number formula selection and methods applied to data from scanners can have a significant impact on achieved results. The paper presents the basic conceptual framework for the use of scanner data for the purposes of compiling the CPI in relation to selected findings of the experimental study performed on real data of five retail chains for the “Food and non-alcoholic beverages” division.

Keywords: Scanner Data, Consumer Price Index, Index Number Formula

JEL classification: *E 43, E 31*

1 Introduction

The Consumer Price Index (CPI) is considered to be one of the most important socio-economic indicators produced in official statistics. The CPI expresses the average change in prices of goods and services purchased by population for consumption.

In the conditions of the Slovak Republic, the data needed for CPI compilation, have been collected through field data collection. During the first twenty days of each month, the employees of the Statistical Office of the Slovak Republic visit shops and service

establishments and record so-called counter prices, prices for which are goods and services offered to consumers.

Within the field collection, those shops and service establishments, where people usually go for shopping, are visited. The development of prices is monitored via fixed consumer basket of goods and services (728 price representatives) of constant quality and similar characteristics, which are selected to represent household expenditure over a year. In this above-mentioned set of representatives, there are 146 items that belong to the area of food and non-alcoholic beverages, which is, in the conditions of the Slovak Republic, the second most expensive area of household consumption following housing costs. At present, this traditional method is gradually replaced in the world, especially in the area of food and non-alcoholic beverages by data from scanners, which are defined by [7] as “*detailed data on sales of consumer goods obtained by scanning the bar codes for individual products at electronic points of sale in retail outlets.*”

This type of transaction data offers more precise and detailed information, and unlike the previous method of obtaining data it also contains quantities of individual goods that are sold in actual period.

The Statistical Office of the Slovak Republic gradually concluded the agreements on the mutual cooperation in the field of statistics with five largest retail chains that have provided the SOSR with the access to this type of data since 2018.

Even though this data is not currently implemented into routine production of CPI, at the pandemic time it represented an important supplementary or substitute source of information because data on prices of some goods could not be obtained without potential threat to employees of the SOSR. It can also be assumed that the consumer behaviour of the population of the Slovak Republic was being changed during the lockdown, similarly to the consumer behaviour of the population of other European countries [9].

Changeover from the traditional collection of data on prices of goods and services to the usage of data from scanners is demanding and long-term process that involves various activities, from negotiations with representatives of retail chains on data provision to addressing methodological and practical issues and testing of different calculation methods in the production environment. The article demonstrates the basic concept of possible use of data from scanners in the field of official price statistics and the first findings of the experimental study performed on real data of five retail chains for food and non-alcoholic beverages in the conditions of the Slovak Republic.

2 Conceptual framework

2.1 Scanner data advantages and disadvantages

Scanner data from a specific vendor and for a given time period represents an exhaustive list of all item codes, their turnovers, and quantities sold. They enable to compile an index from all vendor's transactions or transactions of the store. For example, the assortment of food and non-alcoholic beverages, which is currently the subject of an empirical study at the Statistical Office of the Slovak Republic, is covered, in the conditions of Slovakia, by 7,000 to 29,000 items, depending on the retail chain.

Scanner data enables to statisticians to use what has been sold actually and to include many more items in the CPI calculation in comparison with traditional price collection. It also means that if the information on turnovers is available, weights can be assigned to individual items. The undeniable advantage of scanner data is also a large amount of detailed information about individual products¹, which enables to define the so-called homogeneous groups of products and calculate the price indices of elementary aggregates at a lower level of aggregation than COICOP5². Implementing scanner data in the production of price statistics can also save the cost of traditional price data collection.

Scanner data” reflects the dynamics of actual purchases in each elementary aggregate, as each transaction is recorded. The appearance of new item codes, the disappearance of item codes and changes of their relative importance are visible in the data set. It follows from the above-mentioned, that the scanner data, compared to the traditional data source, has both advantages and disadvantages for the production of the CPI. There is some additional work burden for the NSIs due to increased need for data cleaning and processing, as well as initial cost of setting up the IT system. The dependence of the NSI on individual retail chains is increasing, which means that non-delivery of data will have greater consequences than before. More advanced IT competencies are required from the CPI staff

2.2 Items selection

In [4], two methods of selecting items that enter the calculation of price indices at the level of elementary aggregates are generally recommended, namely the static approach and the dynamic approach. The static approach simulates the traditional fixed consumer basket, with the difference that the prices obtained by the traditional survey are replaced by average prices per unit of goods. Information on actual sale is utilized only at initial selection of items into consumption basket or their replacement in the course of a year.

In dynamic method, the index calculation includes a representative selection of items for every two consecutive months after filtering items out with extreme price changes, items of goods on clearance sales and low sales goods. It means, that the index at the level of elementary aggregate is calculated on the basis of a set of matched representative item codes for items that are actually sold in two consecutive periods.

2.3 Elementary price indices

An elementary price index is the price index calculated for the elementary aggregate. An elementary aggregate consists of a relatively homogeneous set of goods or services with similar expected price changes. They can cover the whole country, individual regions, or it is possible to define them for different types of outlets. Various different methods and formulae may be used to calculate elementary price indices. The choice of index number formula and calculation method can have a significant effect on the results obtained. The European Commission recommends the Jevons price index at the

¹ This information applies if the retail chain has a quality internal classification and is willing to share it.

² COICOP The Classification of individual consumption by purpose

lowest level of data aggregation [3] (see also [Chyba! Nenašiel sa žiaden zdroj odkazov.]), which can be written for the base period (0) and current period (t) as follows:

$$P_j^{0,t} = \left(\prod_{i \in S} \frac{p_i^t}{p_i^0} \right)^{1/N_{0,t}} = \frac{(\prod_{i \in S} p_i^t)^{1/N_{0,t}}}{(\prod_{i \in S} p_i^0)^{1/N_{0,t}}} \quad (1)$$

S represents the set of identical items of goods belonging to a certain category and $N_{0,t}$ the number of identical items of goods. p_i^0 a p_i^t are prices (prices per a unit of goods) of each item $i \in S$ in the period 0 a t .

Theoretically, for homogeneous groups of products, it is also possible to use the Dutot index, which can be expressed as follows [Chyba! Nenašiel sa žiaden zdroj odkazov.]:

$$P_D^{0,t} = \frac{\sum_{i \in S} p_i^t}{\sum_{i \in S} p_i^0} \quad (2)$$

The authors of some studies recommend, in some exceptional cases, to consider the use of the Carli index [Chyba! Nenašiel sa žiaden zdroj odkazov.], which is defined as a simple or unweighted arithmetic average of relative prices or price ratios for the period 0 a t , which can be expressed:

$$P_C^{0,t} = \frac{1}{N_{0,t}} \sum_{i \in S} \frac{p_i^t}{p_i^0} \quad (3)$$

The paper [Chyba! Nenašiel sa žiaden zdroj odkazov.] presents many studies proving significant differences in results between Dutot, Carli and Jevons indices.

When selecting an appropriate index for measuring CPI / HICP, two main approaches can be used, axiomatic and economic approach. From the axiomatic point of view, Jevon index is the index with the best properties. Although it has not been widely used until recently, the trend of its use by statistical offices is on the rise.

The economic approach is based on the economic theory of the consumer behaviour. The economic approach assumes that quantities consumed are a function of the prices, and data recorded arises as solutions of different problems of economic optimization of the consumer. According to this approach, the CPI is defined as a cost-of-living index (COLI). A growing number of economists and other users prefer superlative indices for CPI compilation purposes, such as e.g. Fisher index, because they consider them to be the best COLI approximation.

2.4 Weighted price index formulas

The CPI is currently still determined by means of Laspeyres index. The Laspeyres index, which uses only weights from the basic period, does not reflect changes in consumer behaviour during the reference period and it may be distorted due to substitution of goods. The Laspeyres price index [Chyba! Nenašiel sa žiaden zdroj odkazov.] can be expressed as follows:

$$P_{La}^{0,t} = \frac{\sum_{i \in S} p_i^t q_i^0}{\sum_{i \in S} p_i^0 q_i^0} \quad (4)$$

where p_i^t is the price of i -th product at time t .

The Paasche price index [**Chyba! Nenašiel sa žiaden zdroj odkazov.**] uses the quantity of goods sold from current period and can be written as follows:

$$P_{Pa}^{0,t} = \frac{\sum_{i \in S} p_i^t q_i^t}{\sum_{i \in S} p_i^0 q_i^t} \quad (5)$$

The above-mentioned economic approach in the price index theory assumes that the real value of the COLI belongs to the interval whose upper and lower limit is determined by the values of the Paasche price index and Laspeyres price index.

As it was mentioned in the previous subchapter, the most preferred indices for the purpose of measuring CPI are superlative price indices, firstly proposed by [**Chyba! Nenašiel sa žiaden zdroj odkazov.**]. They can be written as follows:

The Fischer price index [**Chyba! Nenašiel sa žiaden zdroj odkazov.**]

$$P_F^{0,t} = \sqrt{P_{La}^{0,t} P_{Pa}^{0,t}} \quad (6)$$

The Törnqvist price index [**Chyba! Nenašiel sa žiaden zdroj odkazov.**]

$$P_T^{0,t} = \left(\prod_{i \in S} \frac{p_i^t}{p_i^0} \right)^{s_i^0 + s_i^t / 2} \quad (7)$$

where $s_i^0 = p_i^0 q_i^0 / \sum_{i \in S} p_i^0 q_i^0$ and $s_i^t = p_i^t q_i^t / \sum_{i \in S} p_i^t q_i^t$ refer to the proportions of expenditure in period 0 and t ; q_i^0 and q_i^t are quantities sold.

2.5 Chained indices

A chained index provides a measure of cumulated effect of successive price steps. Chain indices are the indices with moving base, id est, with the base from the values of the previous period. Any index number formula can be used for the individual links in a chained index. For example, an unweighted chained Jevons index can be written as follows [**Chyba! Nenašiel sa žiaden zdroj odkazov.**]:

$$C P_j^{0t,mt} = P_j^{0t,1t} \cdot P_j^{1t,2t} \cdot \dots \cdot P_j^{(m-1)t,mt} = \quad (8)$$

If in practice, HICP/CPI are compiled from “scanner data” it is generally recommended to use chained superlative indices due to the higher degree of matching of individual item codes between two consecutive periods and the assumption of smaller differences in price and quantity. However, this assumption does not consider the existence of clearance sales and discounts, which can significantly increase the quantity of goods sold, up to several times. When the discount period ends, the price returns to its original value. However, the situation may turn out to be that population is supplied and it will take longer time until the quantity of sold goods returns to the former/original value. Under these conditions, chained superlative indices tend to decline and only gradually return to their original level (downward chain drift) in comparison with base indices.

In [Chyba! Nenašiel sa žiaden zdroj odkazov.] have been proposed an approach that provides drift free, superlative-type indexes through adapting multilateral index number theory.

This procedure maximizes the number of matched items in data without the risk of introducing drift to chained time series.

2.6 Multilateral price indices

In multilateral price index methods, the aggregate price change between two comparison periods is obtained from prices and quantities observed in multiple periods including the two comparison periods. They were developed for price comparisons across countries. The best known are the GEKS method, Geary-Khamis method [Chyba! Nenašiel sa žiaden zdroj odkazov.], and Country-Product Dummy method.

Multilateral spatial comparison of prices can be simply adapted for comparison over time. Multilateral indices meet the transitivity requirement. The index is transitive if the index that compares periods „a“ a „b“ through period „c“ is identical with the index that compares periods „a“ a „b“ directly.

The idea of adapting the method to the time series context was developed by Ivancic, Diewert and Fox [Chyba! Nenašiel sa žiaden zdroj odkazov.].

3 Empirical study

The received raw scanner data needs to be pre-processed and classified at the level of individual items. Based on “detailed” descriptions of individual products (items) at the EAN code level or on the internal classification of retail chains products, we have defined 354 homogenous product groups for food and non-alcoholic beverages and, in such way we have created, a national, 6-digit level of ECOICOP classification for this area of consumption. ECOICOP 6-digit is common for all retail chains that currently cooperate with the SOSR, id est, the elementary aggregate can be defined both at the level of the Slovak Republic and at the level of the retail chain, but not at the level of regions.

Each product, that potentially enters the calculation of the elementary index, is subject to the assessment of its “importance”. The selection of the products that enter the calculation depends on the calculation method used and the filters applied to the data. Since in the conditions of the Slovak Republic the CPI index is compiled on a monthly basis, data filtering is performed on a set of data that would potentially enter in the calculation of the month-on-month index.

Items whose prices have been increased or decreased disproportionately in comparison with the previous period have been excluded. The limits for the identification of outliers have been set to 0.3 and 3 (outlier filter) after a thoroughgoing analysis of the annual data. Furthermore, those items, whose prices and turnovers fall significantly compared to the previous period are excluded from the calculation of the index at the elementary level. These are mainly products intended for clearance sale, if price change is ≤ 0.8 and, at the same time, the change of turnovers is ≤ 0.2 . This filter is known as a dumping filter. In the case of the dynamic approach method (dynamic consumer basket, which is always created up to date for two consecutive periods),

subsequently products with low sales are excluded as well on the basis of formula [Chyba! Nenašiel sa žiaden zdroj odkazov.]:

$$\frac{s_i^{t-1} + s_i^t}{2} > \frac{1}{n\lambda} \quad (9)$$

It means that the product will be included into the sample for the index calculation if the ratio of the item i in expenditure in months t a $t-1$ exceeds threshold value $\frac{1}{n\lambda}$, where:

n - is the number of products,

λ - is a fixed parameter and based on empirical research $\lambda = 1.25$.

The effect of data filtering can be seen in Table 1.

Data filtering impact on values of chained unweighted Jevons index can be seen in Fig.1. From Fig.1 and also from the results of the experimental study in [Chyba! Nenašiel sa žiaden zdroj odkazov.], it is clear, that Jevons index is sensitive to filter selection. In the specific example given, the Jevons index acquires the lowest values when it is being compiled above an unfiltered database of products, probably, because it is dominated by products with smaller monthly price changes than the average monthly price change.

Table 2. Effect of data filtering (COICOP 01, average month 2019)

Type of filter	Number of items after filtering
Without filtering	60 239
outlier filter	60 070
(outlier + dumping) filter	59 638
(outlier + dumping +low sale) filter	17 057

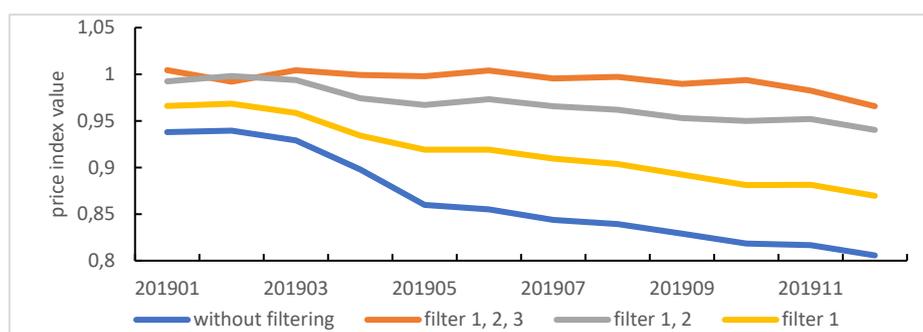


Fig. 3. Impact of the outlier filter (filter 1), dumping filter (filter 2) and low sale filter (filter 3) on the Chain Jevons index value based on example of products of the homogeneous ECOICOP6 group - biscuits and wafers without filling, Dec. 2018 – Dec. 2019

As previously stated, the scanner data allows us to compile unweighted and weighted indices at the elementary level, and the selection of formula and method can have a

significant impact on the results obtained. Differences between individual indices considered are shown in Fig. 2 and 3. It is no surprise that the values of the Carli index are above the values of the Dutot index and the Jevons index. Which also follows from their mathematical properties. [Chyba! Nenašiel sa žiaden zdroj odkazov.]

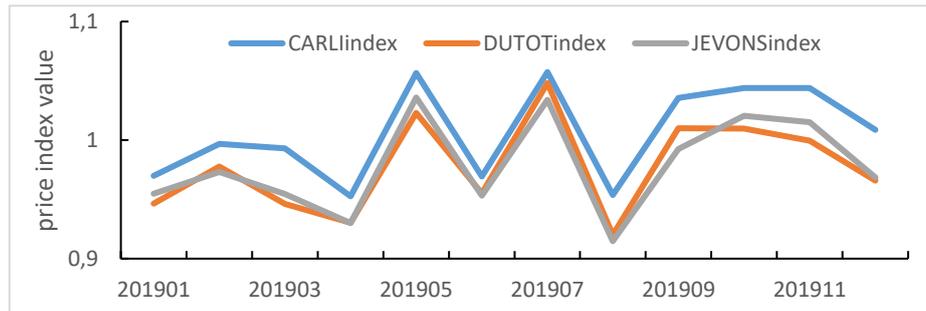


Fig.2 Comparison of the development of unweighted bilateral chained indices based on the example of products of the homogeneous group ECOICOP6 - fresh butter, Dec. 2018 - Dec. 2019

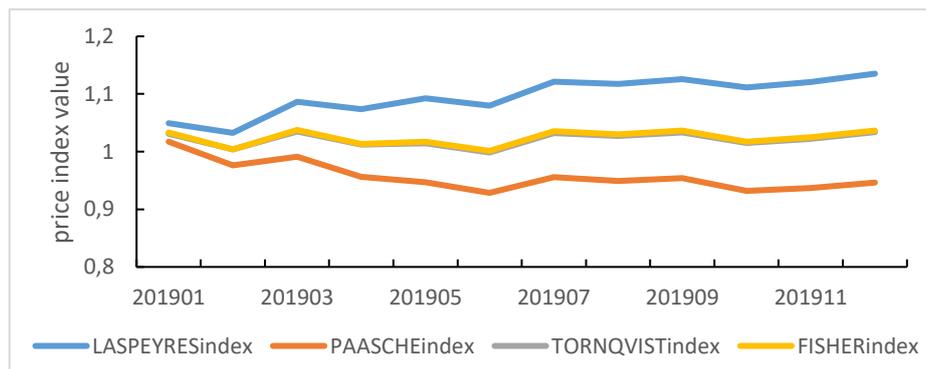


Fig. 3. Comparison of the development of weighted bilateral chained indices based on the example of products of the homogeneous group ECOICOP6 - fresh whole milk, Dec. 2018 - Dec. 2019



Fig. 4. Comparison of the development of the price and the quantity of product sold- butter traditional Koliba, sold in one of the supermarket chains

Superlative indices are based on economic theory and the weights used reflect the changes in consumer behaviour illustrated in Fig. 3. In the fixed basket approach, superlative indices (Fischer, Tornqvist) approximate each other [Chyba! Nenašiel sa žiaden zdroj odkazov.]. In our case (dynamic basket, chained versions of indices) they behave in the same way. Their development is in line with the economic approach in the price index theory, according to which superlative indices approximate the cost of living index and Laspeyres index provides an upper limit and Paasche a lower limit to the COLI.

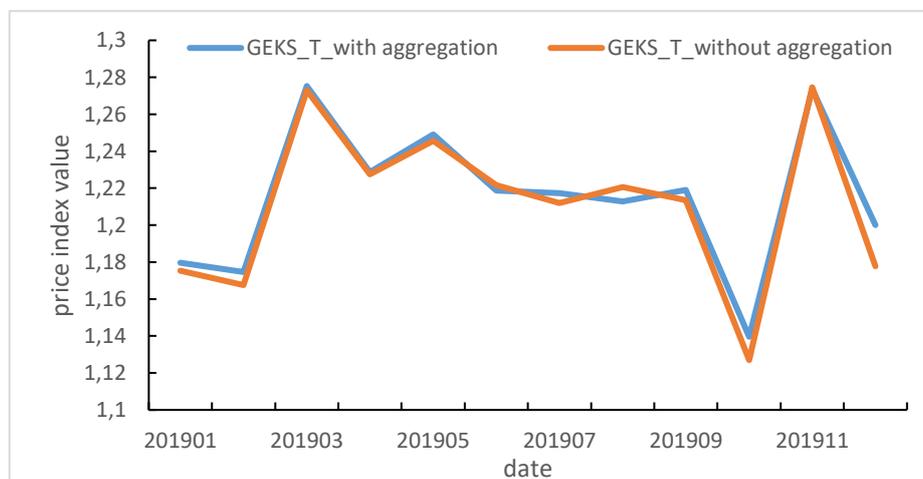


Fig. 5. Impact of the aggregation over supermarket chains on the multilateral GEKS- Törnqvist index results calculated (ECOICOP6 – rice husked, Dec. 2018 – Dec. 2019).

One of the questions that needs to be answer in relation to the implementation of scanner data into CPI production is the question, whether the indices at elementary level

will be compiled above common database of products or above databases of individual retail chains and then aggregate them (Laspeyres formula). In the conditions of the Slovak Republic, the results of the experimental study in this area confirmed insignificant differences between the mentioned procedures in the division of food and non-alcoholic beverages (see Fig. 5), and therefore, a simpler procedure is recommended, and that is to implement the compilation of CPI over a common product database.

4 Conclusion

The Slovak Republic is still in the process of preparation for the usage of scanner data in the official statistics. Some issues have remained unresolved, and they will require further research and experimentation with real transaction data.

In addition, IT system which would combine and analyze data from various sources is under preparation. Despite of this, several experiments on data processing, classification, matching (against the base period or the previous period) and calculating different price indices on real data using SAS or R package software have been performed.

Based on the performed experiments, the same homogeneous product groups for all cooperating retail chains in the division of food and non-alcoholic beverages were made up. Indices at elementary level will be calculated over a common database of matched products, i.e. without aggregation over supermarket chains. As a result of the ongoing experimental study, the threshold values have been set to exclude extreme price changes and clearance goods. It has been stopped dealing with the compilation of CPI over a fixed consumer basket (selection of products from scanner data). Exclusively the dynamic approach will be the subject of the other experiments. However, the issue of implementing scanner data into CPI statistical production is very broad and multifaceted issue and many methodological questions are still unanswered. For example, choosing the right index formula remains the great challenge.

Ongoing experiments will be focused mainly on the possible implementation of the Jevons index, superlative chained indices and especially multilateral indices

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Supporting mechanisms in European University-Business Collaboration

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Abstract. Despite the high innovation potential for universities to play a leading function in regional development, there is an increasing identification of supporting university-business ecosystem. European universities include different types of higher education institutions. Each institution received some sort of external support and extra funding for the application their development and implementation for successful selection at European level. To broaden understanding of cooperation activities, we tried to identify main supporting mechanisms in European success stories. Good practice case studies shared across the institutions are necessary for further observation. In the context of university-business collaboration, this article studies supporting mechanisms which can improve linkages between universities and business. With a sample of 42 case studies, we identified a dominant supporting mechanism in European regions and mutual differences between mechanisms. The main results highlight the relevance of the combination of more than one supporting mechanism which lead to more competitive society and knowledge-based economy.

Keywords: university-business collaboration, supporting mechanisms, innovation, higher education, Europe

JEL classification: I23, O38

1 Introduction

University-business collaboration (UBC) refers to the interactions between any parts of the higher educational ecosystem represents by universities and business through knowledge and technology transfer [3, 10]. Increasingly perceived as a vehicle to improve innovation through knowledge exchange [2]. UBC may have an overall positive influence based on knowledge and technology transfer, especially a strengthening of the regional and national economy and the development of the region

the country themselves [6] and presents a key innovation strategy for sustainable economic growth [31]. The benefits of university-business linkages may be wide-reaching: they can help stimulate additional private R&D investment, they can coordinate R&D agendas and avoid duplications or utilize synergies and complementarities of scientific and technological capabilities [19].

In 2000, the continued significance of academic knowledge for regional economic initiatives was identified by the European Council's Lisbon Strategy [37] which encouraged universities to develop their technology transfer policies and offices to create and diffuse academic knowledge. Strategy Europe 2020 targets smart growth through strengthening the relations between research institutions and industries. Cross-national programs such as Horizon 2020 by the European Commission [11] or OECD New Evidence and Policy Options [30] emphasize the idea of collaboration between public and private sectors to improve innovation performance, generate jobs and better quality of life. Supporting mechanisms need to be put in place to encourage and support cooperation. They should aim to help reduce or eliminate the largest barriers, offers facilitators, and provide incentives that reward universities and business to undertake the activity. This can include creating new policies, strategies, activities, and structures [13].

The purpose of this paper is identified main supporting mechanisms in university-business linkages of good practice case studies across the Europe. In the first section of this article, we examine position of supporting mechanisms in UBC based on literature and introduce our methodological approach. The main aim is a comparative analysis of documents from European Commission (EC) and present the findings related to the supporting mechanisms UBC.

2 Theoretical Framework

The technology transfer industry has become established particularly in the USA in the last 40 years. It has grown as an outcome of legal changes arising from enactment of the Bayh-Dole Act which gave universities ownership of their research outputs [9]. Europe has called for own European Bayh Dole Act that involves one single patent system with uniform validity [13]. Given that human nature is generally characterized by resistance to change [4, 34], the supporting mechanisms aim to change the culture of higher educational institutions (HEIs) [25] and bridge cultural differences between universities and businesses.

The literature shows that support mechanisms are used in number of key areas of UBC. Supporting mechanisms need to be aligned with the culture and mission that facilitating UBC through the fast development of dedicated strategies [38]. The absence of supporting mechanisms causes that UBC remains isolated and a rare activity only reliant on the whims of those individuals willing to engage in collaboration. Furthermore, they are expected to link and connect all levels of the institutions. Taking on the additional task of developing support mechanisms and implementing processes, it requires the university to transform into an institution in which university-business linkages are encouraged, supported and fostered for all relevant stakeholders in regional

development [1]. Location of the HEIs might also relate with the development of UBC. Several international studies point to a differences between countries [7, 23, 24], with a great diversity environment that can support and/or inhibit UBC [17]. Authors in their articles present many instruments and activities for technology transfer provide by HEIs, business sector and government. Academics are increasingly interested in bridging the separate worlds of academia and business despite managing the balance between academic and entrepreneurial activities, [9]. The structural dimension interest for UBC which focused mainly on the commercialization areas of collaboration including patents, licenses, spin-offs, involving primarily a unidirectional flows of knowledge economy [8, 16]. Research on support mechanisms is typically in the middle of the mechanisms supporting the transfer of technologies, such as technology transfer offices and university incubators [35].

At the strategic level, the management of the support HEIs and incentives are properly identified, while the operational level includes the management of UBC offices and promote organizational strategies. Strategic mechanisms promote the new third mission by creating and implementing strategies to support and stimulate UBC activities includes establishing long-term strategies and an inclusive strategic approaches directed at business interaction [8, 20, 38]. For instance, Phan and Siegel [33] found that the most startups generated by HEIs are those that establish well-defined and clear extend strategies. A mechanism used in top management to institutionalize the importance of UBC is the presence of people in business on the HEIs board and the presence of academics on company boards. The HEIs guarantee that with these mechanisms their education and research is going to remain relevant for the society. Operational mechanisms in UBC present one of the most common ways of promoting UBC at the highest level of the institution [15, 27, 36], which emphasize the desired behavior [8, 18]. HEIs give attention to UBC topics in the media inside the HEI and in their respective regions or countries with awards or special events in order to stimulate an innovation environment that support UBC. Some HEIs also promote business and managerial cultures, skills and abilities amongst researchers and students through workshops to improve their chances of successful valorization [26]. The main advantage of operational mechanisms is predominantly the lowest cost, the easiest and quickest to set up [7] because they can be established by stakeholders within the HEI: management and faculty level, or at the individual program, academic or student level.

The using of governance mechanisms aims at mitigating risks of opportunistic behavior and coordinating resources [5, 22], because of governments serve to avoid dysfunctionalities, predominantly in the context of collaboration and integration complementary to the competencies of the cooperating partners [39]. Policy mechanisms can be classified as: economic and financial mechanisms, regulation mechanisms and other policy mechanisms that do not belong to either of the first two categories. Governments provide various conditions, such as – giving a space for UBC strategic mechanisms to creating and involving the establishment of structural mechanisms (e.g., creation of a knowledge transfer center) that can initiate the development of operational mechanisms (e.g., UBC workshops for academics) [13]. Therefore, heterogeneous regional and national research programs have been initiated by governments (e.g., Vinnova – Swedish government agency for innovation policy

which promotes sustainable growth by funding research). Governments have been compelled by the global changes in the competitive and technological challenges to take actions to support research interactions between the two actors. Governments believe that universities could aid in long-term economic regeneration [28, 32].

3 Methodology

In the article, we applied qualitative research to provide responsible results. Our qualitative research started with a review of literature emphasizes the the importance of university-business collaboration and supporting mechanisms which need to be put in place to support and sustain cooperation.

We used a document analysis as a data source in our qualitative research. Furthermore, we evaluated electronic documents – case studies which represent single success stories in university-business collaboration in European regions. These documents offer a rich descriptions and background information which help us to understand other insights.

In the next part, based on previous qualitative research, we analyzed 42 case studies which were published by EC. Each study illustrates example of good practice in university-business collaboration including case studies focusing on different activities [12]. Our research outcome represents 26 European countries which was selected into four European regions (number represent case study quantity by region) (Table 1) – Northern Europe (11), Western Europe (11), Eastern Europe (10) and Southern Europe (10). Countries which were considered for case study selection were current members of the European Union (EU) or those committed to the EU economy as member of the European economic Area (EEA) by the end of year 2018.

Table 1. Classification of countries

REGION	COUNTRIES	NO. OF COUNTRIES IN REGION	NO. OF CASE STUDIES
NORTHERN EUROPE	SWEDEN, FINLAND, DENMARK, NORWAY, ICELAND, IRELAND, UNITED KINGDOM	7	11
WESTERN EUROPE	BELGIUM, NETHERLANDS, GERMANY, FRANCE, AUSTRIA	5	11
EASTERN EUROPE	HUNGARY, SLOVAKIA, POLAND, CZECH REPUBLIC, SLOVENIA, LATVIA, ESTONIA, LITHUANIA	8	10
SOUTHERN EUROPE	PORTUGAL, SPAIN, ITALY, GREECE, CROATIA, MALTA	6	10

Source: Own elaboration based on the case studies [12]

In each case study we have identified four types of supporting mechanisms between HEIs and business which have been used. Related to the central question of the research, we organized information into categories for further quantitative analysis

(Table 2). HEIs represents all types of institutions, which offer higher education, but must be formally recognized by the suitable national/regional authority. The concept of supporting mechanisms includes strategic, structural, operational and policy conditions as we can see in Table 2. The main aim was to find out which of these mechanisms is the most efficient or most frequently used.

Table 2. Four types of supporting mechanisms

TYPE OF MECHANISM	POLICY	STRATEGIC	STRUCTURAL	OPERATIONAL
REPRESENT BY	funding and regulations, organizations/information created by regional/national/international governments	drafting and implementation of high-level plans/methods/series	constructions, personnel, and institutional programs	actions or events of a practical nature
THE MAIN AIM	maximizing economic performance, welfare, or other policy objectives with focus on or relation to UBC	HEIs that will enable it to achieve its long-term objectives with respect to UBC	created a strategic decision within/related to a HEI that enable UBC	undertaken by a HEIs to create and support UBC
RESPONSIBILITY	governments	HEIs	regional agencies, governments, HEIs, business	regional agencies, governments, HEIs, business

Source: Own elaboration based on the case studies [12]

4 Results

As we have shown in previous section, we have analyzed 42 good practices case studies from 26 European countries. Good practices case studies are one of main components of the project „The state of University-Business Cooperation in Europe” which have been conducted during years 2016-2018 by a consortium of Science to Business Marketing Research Centre in Germany for the Education and Culture. These documents were created on institutional level and systematically provide information from its establishment, through educational mission development and building institutional relationships to the present. The project studied the state of UBC in different European countries via more factors like objectives and motivations, stakeholders, barriers, and drivers, supporting mechanisms, activities and key success factors or future challenges. We chose supporting mechanisms due to their importance in overall success of UBC.

The paper provided insights from the support UBC in Europe in four case study regions: Northern Europe, Eastern Europe, Western Europe, and Southern Europe. Most of the regions generated a positive impact in terms of supporting mechanisms both for HEIs and business sector. Territorial dimension of supporting mechanisms is characterized by complex of 10 or 11 studies in each region. In general, there is a dominance of structural supporting mechanisms in all four regions (see Fig. 1.).

In Northern and Western Europe, case studies illustrate a dominance of both structural and operational mechanisms. Universities in Denmark, Finland, Sweden and Norway are leading universities in Europe because of their innovation potential which show results of European Innovation Scoreboard [14]. They provide plenty activities lead to maximize the commercialization of technologies develop by researchers and students. Such as created technology transfer offices and innovation hubs (e.g., Skylab at Technical university of Denmark or Hothouse on Dublin Institute of Technology), entrepreneurial education improves job market perspectives and job performance for students. The character of using supporting mechanisms was slightly different in Southern and Eastern Europe. In these regions, we can see still dominant structural mechanisms, but a mix of other three mechanisms too. Case studies from Eastern Europe provide mainly collaboration between HEIs and big industrial manufactures like Audi, Gorenje, Kolektor Group, GroGlass.

Generally, 90 % studies used more than one supporting mechanism. The combination of mechanisms in multiple ways is useful in removing barriers. As illustrated in Fig. 1., 83 % of all case studies (it represents 35 case studies) have been used structural, 59 % operational, 28 % strategic and 14 % policy supporting mechanisms.

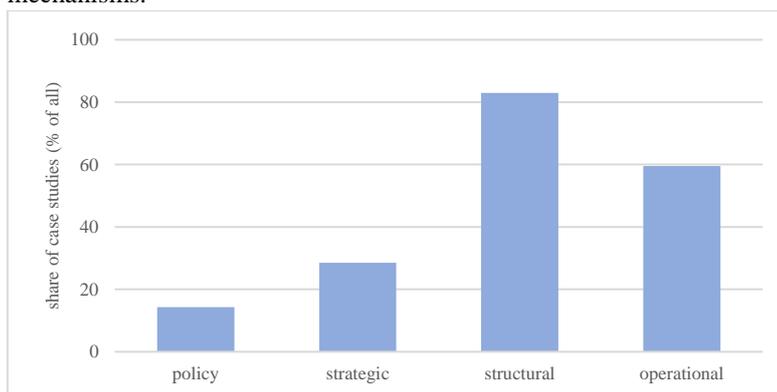


Fig. 1. Analysis of supporting mechanisms used in case studies

Source: Own elaboration based on the case studies [12]

Structural mechanisms were the most applied in every region of Europe (Fig. 2). This type of mechanism consists of activities in the field of bridging structures, infrastructure, employability, career services and external integration structures. It is the most common mechanism because of cooperation more actors like universities, government, and business too. Bridging structures representing technology transfer offices, innovation, or industry liaison offices. Likewise, career offices and alumni networks structures are very helpful for students and graduates. However, infrastructure like science parks, incubators and co-working space can be expensive, but necessary for external integration and cooperation with partners. Good example is the University of Twente (UT) in the Netherlands. The key mechanism in this case is the Kennispark Twente and its Foundation, which join initiative of local stakeholders. Together, they

are drivers behind regional innovation and sustainable growth in the Twente region. Their collaborative activities have led to over 100 new start-ups per year on average. Other recent mechanisms are the establishment of three investment funds – The Twente Technology Fund, Innovation Industries and The Dutch Student Investment Fund. Twente's entrepreneurial ecosystem has been very attractive for foreign investors, but the UT spin-offs account 10 % of the fastest growing high-tech companies in the Benelux region. On the other hand, two of the barriers is underdeveloped investment climate and limited proportion of new jobs in the Twente region that require higher or medium levels of education [13].

Furthermore, operational mechanisms were on second stage. They present academic and student network dedicated to UBC and external communication. In most universities is offered entrepreneurial courses for students and academics, information sessions and forums too. HEIs with high development of UBC apply a set of mechanisms at both operational and structural level simultaneously (Fig. 2.). For instance, at the Athens University of Economics and Business (AUEB), there is an important operational instrument, designed program of education and entrepreneurship development with input of industry consultants and practitioners – The Innovation Design and Entrepreneurial Action (IDEA) programme developed by the Athens Centre for Entrepreneurship and Innovation (ACEin). It uses project model based on open innovation to help and assist talented students, startups or entrepreneurial teams to solve and unravel their entrepreneurial potential and specific business issues. One driver of UBC was the investment by the Municipality of Athens, to create the special office and incubator space at ACEin. The challenges are now to make IDEA programme more sustainable and bring entrepreneurial spirit in engaged students and businesses. Future challenge is financial self-sufficiency with good strategy in funding [13].

Strategic supporting mechanisms include paper and implementation strategies. The strong association of strategies incentives with supporting UBC, documented mission, top level management committed to UBC or coordinated communication approach for UBC [13]. We want to indicate the Strategic plan for the University of Tartu - an ambitious Estonian business university through the development of enterprising spirit and entrepreneurship. The main supporting mechanism is the leading university' strategy and its implementation. Every year, university makes the management plan for the following year where defines the types of activities that should be financed in the next year. Some activities that need longer period to start are marked to be financed for two, three or more years. There are five priority areas in the university strategy: research, teaching, entrepreneurship, organizational development and protecting Estonian language and cultural heritage [13]. On the contrary, the great barriers are financial resources and lack on an entrepreneurial ecosystem around it because of geographic location.

In the last stage, policy mechanisms were used in the minimum of case studies. In 26 countries involved in the study, policy mechanism using only in six studies

(14 %). These types of activities often fall into ministries or agencies in countries. In few countries, strategies are translated into specific instruments and unique programs. Nonetheless, it is also interesting to see position of policy mechanisms, due to financial government instruments like grants, tax credits as well as the creation of a legal environment supporting research and development and may benefit from most regional/ national research programs initiated by governments [21, 32]. In Northern and Western Europe, we found one example which present active cooperate universities with local influence (Fig. 2.). We chose the policy direction of the Bavarian state government in Germany, including initiatives to push Bavaria and Germany's Silicon Valley. The proactive approach taken by the State Government focus and finance allow centers of innovation and new ventures to develop into world leaders. On the contrary, to foster entrepreneurship need to be created multiple access point to entrepreneurship thinking and acting.

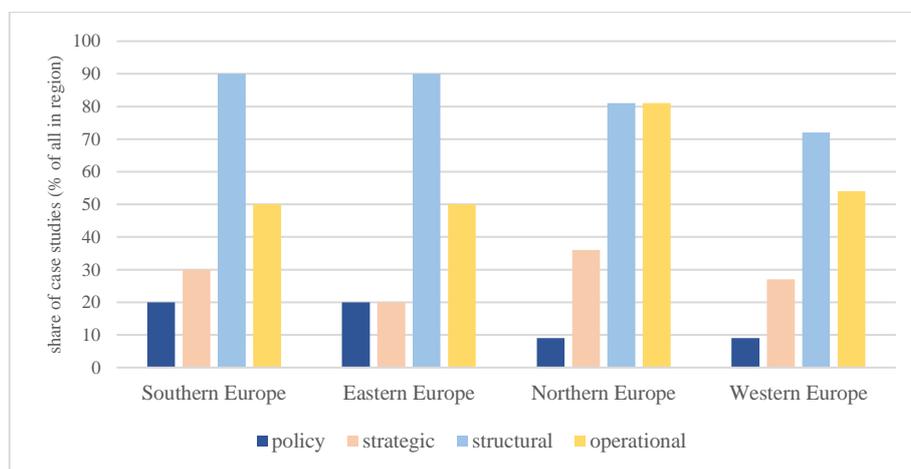


Fig. 2. Supporting mechanisms divided into European regions

Source: Own elaboration based on the case studies [12]

5 Conclusion

In conclusion, we can say that supporting mechanisms are important during the foundation, development and all functioning each success story of UBC. But all stakeholders are still facing lot of barriers - lack of funding and resources, regional and cultural differences, few business activities, bureaucracy and more. It is very important focus on developing the drivers an using a wide variety of mechanisms supporting UBC. EC has attempted to address the modernization of European HEIs mainly through several policy instruments which encourage and pressure HEIs in equal measures [29] to make a greater contribution to sustainable economic development. However, the EC policy supporting UBC does not directly regulate organizational mechanisms because these are often regulated at national/regional level [16].

This research paper has clearly shown that supporting mechanisms have special place in development UBC in European regions. Having a support for collaborating with HEIs is an inseparable part of each case study. It is important to note that each case study is individual and unique. They try to fit the region's strength, environmental framework and regional limitations. An overview of our research shows, that HEIs use four types of supporting mechanisms: policy, structural, strategic and operational. A brief across Europe showed the variety of instruments that regional stakeholders use to support UBC activities and highlight many gaps. The most used mechanism was structural. It encourages new offices and infrastructure which can bridging structures between universities and business in regions. The involvement of different institutional actors (HEIs, firms, ministries/agencies, etc.) create common aim strengthen their competitive advantage. Without suitable national and regional government help it would be more difficult to create successful UBC.

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Ad-hoc approaches to stress testing in the pandemic era

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Abstract. Recent events have updated the structure and character of stress testing of the banking sector. The adjustments implemented to better inform the policy response have however varied across the world. We review different approaches taken by the three global authorities during the pandemic year with the aim better to understand motivations for the adjustments in the regulatory framework in presence of heightened uncertainty and adverse unexpected shocks. We also provide an insight into what has changed in the design, scenarios, and communication of the stress testing results during the pandemic around the world.

Keywords: stress testing, financial stability, covid-19

JEL classification: G21, G28, D53

1 Introduction

Banking sector had been enjoying a relatively healthy period of time with reasonably comfortable levels of capital and liquidity buffers before the pandemic have changed the world. Although monetary stance has already been quite loose, shortly after the onset of the restrictions, unprecedented number of supportive measures have been taken as a response to contain the initial impact to the banking sector.

Deep economic impact of the pandemic still weakened the solvency position of banks to a considerable extent. In order to tailor the response measures adequately, or more specifically, to identify more vulnerable institutions while maintaining the accommodative prudential policy stance intact, an update in the assessment of banks resilience deemed necessary.

Such a unique shock as pandemic surely requires both revisions to the scenario design as well as to modelling approaches. In general, stress tests have been reviewed and changed in two directions. In the short run, special emphasis has been placed on what effect does the pandemic shock have on the banking sector and the economy. Such

understanding is then important in the long run to help identify eventually vulnerable institutions where targeted supervisory action would have to be taken.

Although, the main goal of general stress testing is to consider performance of the financial system in extraordinary conditions, only when such situation occurs, we better comprehend what is the necessary adjustment in this practice. Truly, financial system is a complex organism consisting of a whole set of financial institutions, financial market, and payment systems, and therefore it is not easy to put it through a comprehensive analysis (Baudino, 2020). On top of that, considering the shocks that the world has been through during the pandemic were beyond any imagination.

2 Design option for the rainy days

One of the challenges to the design of stress testing exercise in the pandemic times is to take aboard new metrics related to healthcare, e.g., infection rates, speed of reproduction, hospitalizations, mortality rates etc. Yet, almost 2 years into the covid-19 crisis, general understanding of these metrics, their mutual relationships and their effect on economic variables are still not sufficiently understood. Quicker alternative therefore has usually been to perform sensitivity analysis based on existing scenario. One option is an increase in the level of stress represented by certain stress indicator. Another option is to design a new scenario encompassing some deeper story of economic contraction. This however would have to entail an assumption of the strength and duration of the shock *per se*, which as we have witnessed in the pandemic is very difficult to predict.

Consequently, there is more uncertainty around the scenario path than we have been used to accept in the past. This uncertainty makes us to accept higher number of scenarios, or to accept some variation in the stress variables, or alternatively to accept the representation of the outcome in the form of achievable ranges of results. Such sacrifice could however yield much less precise results if working with a longer horizon.

Further to the described uncertainty, inclusion of the policy response might also be necessary. Especially in case of the early massive pandemic relief that we have witnessed soon after the onset of the pandemic in late spring 2020, it would be helpful better to understand their quantitative impact.

Such early policies have also run across different policy domains. Regulatory and supervisory relief measures are different in nature to monetary easing and credit support measures, or public guarantees to absorb the borrower credit risk. They are not only different in nature, size, duration, connectedness, but also in their pass-through to the banking sector or economic activity as such.

Even if all these challenges have been answered, the models that we have been using in the past may well not be suitable for the new normal. Transmission channels may have been amended, duration of shocks changed, effects less reversible. Overall heightened uncertainty around the pandemic related stress test results may in turn affect

the decisions about the extent to which such results are disclosed. Credibility of such results might be questioned and posing a challenge to their communication.

Rich additional empirical and theoretical insights for the design and implementation of stress tests and regulators' incentives are coming from the academia. Additional measures of financial stability risks that could be incorporated into supervisory stress tests have been proposed by Chavleishvili et al. (2021). One of the very vocal approaches to measure potential source of vulnerabilities by incorporating the macro-financial feedback is the Growth-at-Risk approach, promoted further by Adrian et al. (2020). Some scholars (e.g. Shapiro and Zeng, 2020) are building theoretical models to search for optimal stress test scenarios and bank regulators incentives. They provide a nouvelle stylized framework of stress test designs, where decision makers keep the trade-off opportunities in mind, to keep the bank afloat in the stressful economic situation. In terms of communication there is a stream of literature looking at the optimal degree of transparency when a regulator conducts either an asset quality review or a stress test or both (e.g. Inostroza, 2020). In general, some new studies refer to the Covid-19 pandemic, to its impact on the economy and the potential impact on banks and their stress tests.

3 *Ad hoc stress test approaches*

All three main global regulatory authorities have conducted their ad-hoc stress tests in the early stage of the pandemic in 2020.¹ The ECB and BoE have scrapped their regular exercises and replaced them by ad-hoc stress tests in the earlier date (May and June 2020). The Fed in the U.S. has exercised their planned annual tests as they would in a business-as-usual mode but added a special sensitivity analysis published in June 2020. All three exercises took place already in the period of severely worsened economic conditions, following lockdowns in the early second quarter of 2020.

Proposed scenarios have therefore been derived from the early understanding of potential fallout in the Common Equity Tier ratio (CET1) in the respective economies. While the ECB has worked with two scenarios, one central scenario accounting for a drop of 190 basis and an alternative scenario of a severe (adverse) downfall (triple that size, 570 bps), BoE has been working with a single scenario of a downfall amounting to double the basic size of a CET1 fallout (380 bps). The Fed has been addressing the issue with one more layer of dynamics, adding different shapes of fallout and respective consequent recovery (V-, U- and W-shaped).²

Overall, approach to what policy responses have been included into the scenarios has been guided by whatever has been known to date of the respective stress tests publications. These included a regulatory relief (borrower credit relief schemes),

1 Bank of England (BoE), European Central Bank, Banking Supervision (ECB) and the Board of Governors of the FRB (Fed), ad hoc stress testing exercised have all been conducted between May and July 2020.

2 By the date of publication, it was clear that recovery would be rather quick and strong once restriction measures were to be relaxed.

dividend restrictions, and also some monetary and fiscal policy responses limited by contemporary understanding of what the relevant measures are capable to bring (ECB 2020). On the contrary, the latter policy responses (exceptional governmental support measures e.g. in the area of unemployment insurance) have not been included in the U.S. Fed analysis.

All three authorities have communicated their results stressing higher than usual uncertainty around their scenarios and advised on taking special caution in interpreting the results. At the time, the world has been learning about the medical and social risks, vaccine rollouts were still a distant future and outlook has been referred to sailing in an uncharted territory. The main idea was to place an anchor and indicate the most likely outcome given the limited volume of information.

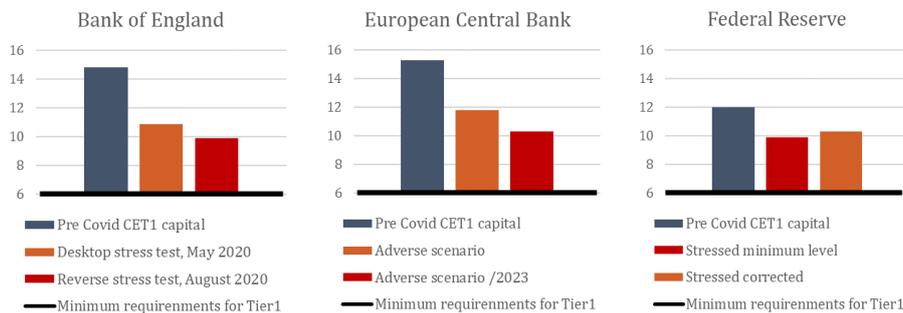
More specifically, the use of tests was to understand the implications of these eventual scenarios to bank capital and to make participating banks submit a new capital plan after the updated stress tests made public (Quarles 2020).

4 Stress testing results

The background principle of the stress tests remains the same. There have been bank buffers of capital reinforced over the good times when the economy was growing, so it can be drawn from when the economy is in stress. The first result of the stress scenario is therefore the extent to which the CET1 capital ratio will be depleted considering assumptions materialized in the scenario.

The 2020 ad-hoc results did not seem to be as dramatic as the pandemic narrative would signalize. However, borrower credit relief and other significant measures are already accounted for. The downfall in the CET1 ratio therefore ranged between 2 to 5 percentage points across the global authorities. This indeed was a significant fallout, however still well above the minimum threshold of the Tier1 ratio and most importantly, vastly milder than the pandemic situation would produce if the response would remain unattended.

Figure 1. Stress test results



Source: BoE (2020), EBA (2020), FRB (2020)

Extra caution shall be used not only due to heightened uncertainty related to the pandemic outlook, but also due to rich properties underneath the above single projected responses of the CET1 ratios to stress.

The EU adverse scenario, for instance, reflects a subset of the financial stability risks that EU banking sector is exposed to following the forward guidance on the low level of interest rates and unsustainable levels of debt that could trigger repricing at the financial market and vulnerable position of the balance sheets. On the other hand, Bank of England purely accounted for the fallout due to restrictions government compensated by continuous credit support, government and central bank guarantee and funding schemes, and relaxed solvency requirements.

Notable differences have also been present in the outlook horizon. Although all the authorities have been reporting on the trough (maximum stress / minimum level of achieved CET1) and aggregate (corrected) effect, Bank of England was looking only at 2020-2021, while the European authorities were much more long-term oriented, looking through the events until 2023 (US Fed until end 2022).

It is of course questionable whether long term outlook has solid grounds in the period of such an uncertainty. It must be noted that it has always been important in Europe to relate stress test findings with the general economic outlook and the ECB projection exercise with the 2-3 years horizon (de Guindos 2020).

Applying long horizons could be tricky in the fast-changing environment. Having the benefit of looking back to the assumptions, we can see that adverse scenarios were framed around the freefall of asset prices.³ This is a usual setup to expect asset prices to fall with fading demand, however present circumstances of advanced income and wealth inequality and reconsideration of the value of a comfortable, liveable space by households around the world during the work-from-home revolution has changed the rules of the game.

5 Conclusion

Stress tests are designed to provide a useful forward-looking assessment of banks resilience and provide an authority with a toolkit to assess the conditions in the banking sector under special circumstances. Current pandemic is certainly such a special circumstance when a first grasp of general understanding of a new phenomenon and its complex system-wide impact to banking sector should be studied. It helps in turn in shaping first aid policies, designing supportive measures in the credit market as well as in setting new pillars of expectations in the uncharted waters for information exchange between the participating banks and the regulator.

This short contribution has attempted to summarize the new features of stress testing exercises across the three main regulating authorities around the world, pinpoint their different approaches during the pandemic year and shed more light at their landmark

³ BoE Desktop Stress Test for instance assumed residential property drop of 16% and equity prices by 23%. In reality, residential prices have increased by more than 6% annually an equity prices by more than 14% to June 2021.

importance to the adjustments in the regulatory framework in presence of an adverse and unexpected shocks. We found that the largest global authorities have concentrated their stress testing exercises around the assumed CET1 ratio fallout rather than complex economic consequence. These exercises have been done using different horizons, while balancing between being quick in assessment (few months into the pandemic) and having an informed analysis.

The aim has therefore not been to capture the complexities of specific early pandemic stress testing exercises, but on the contrary to paint a summarizing picture of changes, challenges and guidelines that have been modified in this unprecedented historical crossroad.

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SHARED SERVICES CENTERS: Theoretical Introduction and Practice in Pandemic Era (Case of Slovakia and China)

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Abstract. Since 2019, we have witnessed the global pandemic, which has affected all areas of economic life in all corners of the world. Neither Shared Services and Centers (SSCs) providing this type of services do not represent an exception and to some extent were hit by a pandemic. Shared services can be considered as a sector that constantly progresses and develops. This area is one of the few economic regions, where the pandemic has not left negative impacts and just the opposite. It has encouraged further development and progress of centers providing this kind of service. The article is an introduction to SSCs. It offers an overview of basic literature sources defining SSCs. It also includes an overview of SSCs resources according to functional management areas. The issue of SSCs is explained on the example of Slovakia. The article compares this small European country to the world leader in this area – China.

Keywords: Shared Service Centers, Slovakia, COVID-19

JEL classification: C 13, F 49, L80

1 Introduction

SSCs represent effective business processes for large as well as smaller multinational or national corporations. In theories we have a number of authors who are devoted to the issue of SSCs and the purpose of this article is to indicate the reader to this topic.

Several common features can be uniformly labeled as motives for building SSCs in CEE. Particular attention is dedicated to a small country located in Central Europe - Slovakia. The country represents a border between Western European and Eastern European countries and many foreign companies decided to build SSCs in this country. Other factors that can be labeled as country's positives for this area are also subject to examination of this article. For a better understanding of the investigated issue, the

small European country will be compared with the global leader in this area – with China.

Global Pandemic caused by Covid-19 disease largely influenced company life around the world. SSCs in China and in Slovakia are not an exception. They had to adapt their activities to changed conditions and organize them to ensure the protection of life and health of their employees.

1.1 Methodology

The scientific article aims to point out the motives for building SSCs in Slovakia and China, and to point out the effects of Covid-19 Pandemic on the functioning and activities of these centers in given countries. The article represents an introduction to the SSCs on the example of Slovakia, compares it to China as one of the world leaders in this area.

The study of theoretical resources of the literature was the basis of the compilation of the literature overview. In the literature references, only a few of the quantity of resources are dedicated. Study of theoretical resources of the literature and the analytical-synthetic method represented the basis of subsequent processing of the second part of the article, which is defined by shared services and the basic motives leading to the company to build SSCs in these countries. Based on the macroeconomic differentiation, the issue of SSCs in Slovakia was possible to compare with the situation in the research area in China. For simpler distinction and comparison of the differences, the author used the two tables and graph.

2 Introduction to the issue of SSCs (on the example of Slovakia and China)

In the case of SSCs, we can talk about a comprehensive topic that can be examined from several aspects. In this section of the article, we will present a brief overview of theoretical resources of literature. They represent the basis of subsequent investigation in various areas. Subsequently, we will demonstrate Slovakia as a country belonging to the CEE region and compare this country with a leader in SSCs – with China. Part of our examination will be comparing the impact of the Covid-19 Pandemics on the monitored countries.

2.1 Theoretical background of SSCs

There are many authors (researches and agencies) defining shared services. „Shared services is a term defining operational philosophy that includes centralization of those administrative functions of the company once carried out in separate divisions or locations.“ (Investopedia, 2021) It is therefore a service that can be shared between the individual business units of the company. Such services can be included in, for example, finance, purchase, business supply, wages, rental of premises and last but not

least information technologies. „SSCs provide international support services for their parent companies and other subsidiaries or execute specific outsourced business processes for third-parties from abroad.“ (SARIO, 2021) “The SSCs, is defined as a partly autonomous business unit that operates consolidated support activities, such as accounting and human resources (HR) and provides services to internal clients.” (Richter, Brühl, 2016) According to Schuppan T. (2019) SSCs are “special form of IT-based tasking”.

As can be seen from the previous text, many authors define SSCs and there is not just one correct definition. There are a many others different resources dedicated to SSCs. The following table shows a short overview of SSCs resources divided by functional management areas.

Table 3. SSCs sources (by functional management areas)

Functional Areas of Management	Source
Finance	GONZÁLEZ, A., SCHREIBER, B., JIMÉNEZ, M. (2019)
	ZHAO, L., JIN, S., HUANG, W. (2021)
Marketing	WATSON, J. (2016)
	BOOZ & COMPANY (2011)
Research & Development	RENKEMA, M. MEIJERINK, J., BONDAROUK, T. (2021)
	PÉREZ-MORÓN, J., MARRUGO-SALAS, L. (2021)
	JAIN, P., AGGARAWAL, R. (2019)
Human resources	ROZHWELL, A., HERBERT, I., SEAL, W. B. (2011)
	STEVENSOM, M. (2019).
	CIPD. (2021)
	ŚLUSARCZYK, B. (2017)
	MARCINIAK, R. (2013)

Source: processed by author

The resources stated above can be considered as a basis of theoretical knowledge of the issue in a global scale.

2.2 Motives for Creation of SSCs in Slovakia (comparison with China)

Development and building of SSCs in CEE countries began in the 1990s. The largest expansion in building SSCs in the region has occurred since 2004 when the European Union (EU) started to expand. Several CEE countries entered the EU and became so more attractive to foreign investors. (Marciniak, 2014) In the following section, we focus on Slovakia where more and more centers of shared services are built and improved in this area. The collected information we compare to the world leader in this area - China.

Both countries are a place where a number of foreign companies want to build their SSCs and so use the potential and benefits that the countries offer. Through Table 2. we point out differences that countries differ from macroeconomic point of view.

Table 4. Basic macroeconomic indicators of the Slovakia and China (2020)

	China	Slovakia
population	1,4 (bil.)	5,45 (mil.)
HDP per capita (in USD)	10 925,728	19 156,89
Inflation (in %)	2,42	1,92
Unemployment (in %)	5,15 (2019)	6,69
Global Finance Safety Index Score	26th place (8,06)	85th place (10,84)
Global Competitiveness Index	16th place	50th place

Source: processed by author according to data from WORLD BANK (2021); GLOBAL FINANCE (2021), IMD World Competitiveness Center (2021)

Although Slovakia and China are diametrically distinct in their size and quantities of residents, both are centers of interest of many foreign companies that want to build their SSCs. The decision of foreign investors can be influenced by the position of the country in individual indexes. More secure country according to Global Finance safety Index is China. This country is on a better position according to Global Competitiveness Index too.

In Slovakia, there is a large number of SSCs, whose countries of origin are primarily North America (28 %), Western Europe (63 %), Asia (8 %), or South America (1 %). (SARIO, 2021)

To place foreign companies or use SSCs in Slovakia leads several reasons that can be considered as the positives of that country: language skills (English 91 %, German 60 %, Russian 12 %), qualified labor force, high adaptability of the workforce, constantly growing network of infrastructure and transport (TEN-T system), the currency of the euro, political stability, high economic performance, the activity of the institutions (SARIO, Ministry of Economy of the Slovak Republic, or the Ministry of Social Affairs and Family, Forum for business services centers.

The relevant ministries and eligible agencies are actively involved in building an attractive investment environment in the country, offer incentives for building SSCs and present this activity abroad. The successful examples of specific centers of shared services established in the country. Examples of such companies are AT&T, DELL, IBM, COVESTRO, Deutsche Telekom Systems Solutions Slovakia and others. (SARIO, 2021)

For comparison, we also state the situation in connection with SSCs in China.

Over the past 5 years, more than 70 % SSCs was created from a total of 1,000 SSCs in the country. From the original intention to increase the financial efficiency of foreign companies grew gradually to digital transformations.(ACCA, 2020)

Corporations are motivated to build SSCs in China by several factors: cheap work force, population is sufficiently qualified, many Large Universities and Colleges, government incentives (encourage large but also smaller foreign corporations to place their SSCs right in China), China's State-Owned Assets Supervision and Admission

Commission of the State Council (manage many large state enterprises in order to attract new SSCs to the country), IT and communications infrastructure, proximity to existing operations. (KPMG, 2014)

The EF English capability index 2018 advises China to a low level of English language knowledge. Only 1 % of country's population is actively using English. In large cities (in the north, East and South – Beijing, Shanghai) this share is higher. Portuguese is significant which is used as official language in Macau and Spanish. Both languages were expanded in the country, especially thanks to the trade with south-american countries. People near the northern borders speak Russian. (GoEast Mandarin) Areas providing services for the northeastern Asian market require Japanese and Korean language. (AmCham Shanghai, 2016)

SSCs in Slovakia are located in several Slovak cities. The main area of interest is the capital of Bratislava (Dell, IBM, PwC, Henkel, Amazon) and the second largest city of Slovakia - Košice (Lenovo, IBM, Siemens). SSCs are also located in other cities such as Trenčín, Žilina, or Kysucké Nové Mesto. (SARIO, 2021)

In the case of China, areas such as Beijing, Shanghai, Guangzhou and Shenzhen were in the center of interest. The Chinese government seeks to improve geographic capacity and capabilities through the development of other places that are not so expensive and crowded - Dalian, Tianjin, Wuhan, Chengdu, Xi'an. "New places" of interest are trying to distinguish from each other. They implement The Single-Center Mode - each of them is specialized in a different kind of services and markets. (KPMG, IQPC)

We can conclude that while in Slovakia it is a provision of relatively equal kind of services in individual cities, in China, cities are specialized in a particular type of service. They increase their quality and try to enforce in a competitive struggle.

2.3 Impacts Covid-19 at SSCs in Slovakia and China

Global Pandemics hit all the areas of society. In this section, we will focus on SSCs based in the Slovak Republic and in China. It was necessary to pay higher attention to global mobility, including changes in travel rules or personnel policies. In most cases, it was necessary to consider a temporary stopping of the work or performing the work from home office. In the case of SSCs, it is an optimal way to solve the situation from home office. It can be said that in most of these centers, this way of work can be done almost 100 percent. (PwC, 2020)

The BSCF carried out a survey last year, which was the study of the impact of pandemics to implement activities in SSCs in Slovakia. It follows from this survey some interesting facts.

Firstly, it is important to say that up to 97 % of the state that they continue without significant restrictions or problems. The remaining 3 % of centers confirmed partial problems. The development in SSCs in Slovakia was supported mainly by the possibility of employees of these centers carrying out work from home office. In 34% of SSCs in Slovak, it performs work from home office over 90 % of the total number of employees of the company.

Changes in work organizations are expected in workplace in SSCs. Up to 41 % of member companies are planning 1-2 working days to work out in the office and 3-4

days to allow work from the house. In the case of 28 % of companies, full flexibility will be allowed according to individual needs of employees. However, 13 % of companies continue to prefer the greater part of the work to do directly in the offices. Most SSCs prefers and implements the work from home office to their business activity and their next step will reduce offices. The positive development was also noticed in the productivity indicators of SSCs, where companies recorded a partial increase and a 3 % significant increase in labor productivity. Pandemic did not significantly affect the productivity of 72 % of BSCF. However, in this context, it should be noted that there is an overlap of differences between working time and relaxation for this indicator.

Pandemic can be regarded as a stimulus, which led to the development of automation and robotization in centers. As is apparent from the above survey, 25 % of SSCs said they would plan to automatize 10 – 20 % in the next 2-3 years. In the case of 19 % of membership companies, automation and robotizations in the next years are more than 20 %. 6 % of companies aim to achieve a level of automation at less than 10 %. However, there remains 41 % of SSCs in Slovakia that did not define any specific objectives about automation and robotization.

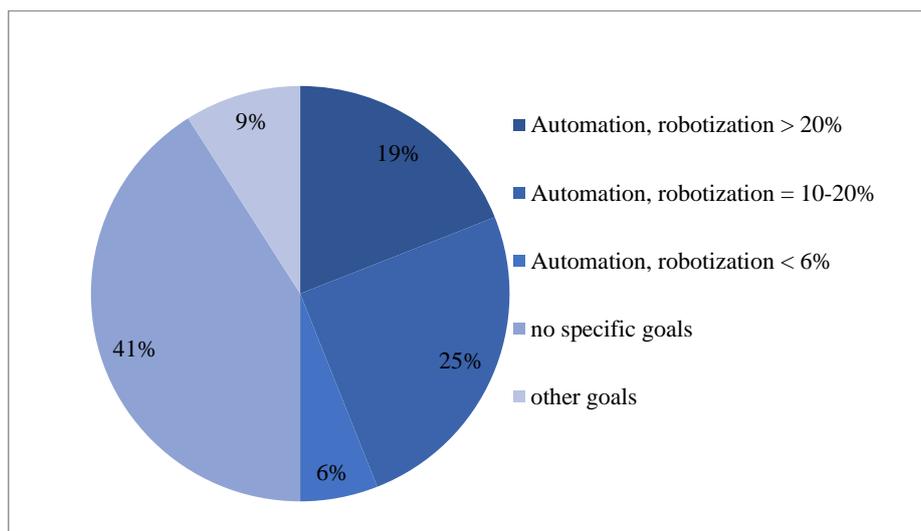


Fig. 3 Share of automation and robotization od BSCF memebers in 2020. Source: processed by author according to data from American Chamber in Slovakia, BSCF(2020)

In practice, several types of automation and robotization can be distinguished. 78% of BSCF member companies have decided to implement automation of internal processes as a main type and data reporting automation as well.

China looked at the pandemic situation from a different point of view. At the beginning of 2020 the pandemic was broke out in this country. China was the first country that faced challenges in relation to the measures against the spread of the virus. These measures also hit the SSCs. The Position of China was very challenging because the whole world watched how it will proceed.

As the first in the world introduced a large work from home office experiment and at the end of 2020 200 million people working remotely. The immediate solution that has been considered a temporary, became potentially permanent solution to the future. 67 % of respondents say remote work will be a key of operational design. There is every possibility, that we could see a rapidly increasing number of China's shared service employees working from home office in the future. (Hampton, 2021)

Despite the positive feedback from SSCs, they describe following challenges: continuity of hardware infrastructure, lack of remote work, insufficient home office space. Zhan Yuqi (Aecom's head of process excellence and transformation Greater China) defined following problems: reducing the effectiveness of communications (less face-to-face contact), or fewer people working on time-sensitive tasks. After the extraction of Pandemics 1/3 SSCs leaders foreseen a positive shift in automation and digitization of workers.. (Deloitte 2021)

In China, the flexibility of shared services will be greatly affected by corporate culture and background. There is a great proportion of businesses that are owned by the State in China. Tony Lui (director of Samung's HR SSC), predict future developments in SSCs in China in two ways:

- a) In state-owned companies and companies with a deeper East Asian culture, flexibility will be reduced as the normal situation is reviewed after the epidemic.
- b) In globalised multinational companies and local Internet companies, mobile office will become the norm and digitalisation will continue. (Hampton, 2021)

3 Conclusion

SSCs deals with the amount of authors and SSCs are defined from different points of view. The article has brought an overview of sources dealing with SSCs according to the functional areas . This is a basis of further exploring this issue. The main theme (SSCs) are further specified on the example of a particular country - Slovakia. For a better understanding of the explanatory problems, we compared this small European country with the world leader in this area - China. In examining SSCs in Slovakia and in China, we found the following differences:

- The Slovak Republic is still the largest development potential in the largest cities of the country as Bratislava and Košice, China passes through the new places because the original places of interest are already crowded;
- In Bratislava we can find centers providing various types of services (Call Centers, IT, Finance Management), but China uses SIGLE-CENTER MODE, thus a particular place / area specializes only for one type of service (for example IT);
- The majority of SSCs in Slovakia provide services for foreign companies/countries and the majority of SSCs in China provide services for the Chinese mainland;
- The most used foreign language in SSCs in Slovakia is English, in China is most used Spanish, Japanese, Korean or Russian language.

- China was the first country struck by Pandemics and all the measures it has introduced and still introduces are pilot measures that follow countries around the world. Slovakia follows this model with a certain period of time;
- China is a pioneer at work from home office and creates „New Normal“. Slovak centers these trends (but also other trends) only implemented in their strategies.

Finally, it can be concluded that although Slovakia compared to China is a small country dependent on foreign markets, we can expect great potential to grow and further develop in the SSCs area. It will be important to monitor the development of SSCs in Slovakia in the coming years and to compare this development with previous results but also other countries within the region. Further development of these centers will be contained in the following article.

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Economic impact of MICE tourism in Slovak Republic

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Abstract. The Meetings, Incentives, Conventions and Exhibitions (MICE) sector of tourism has been rapidly expanding until the world met COVID-19. Purpose of this research is to analyse and identify the economic impact of congress tourism as a part of MICE sector in Slovakia with regard on GDP and revenues of accommodation services. To achieve this, first, paper discusses the latest data in MICE tourism sector of Slovakia in comparison with other countries. To accomplish the main goal secondary data were collected and the variables were assessed. Correlation and regression analysis were used to analyse impact of MICE tourism towards on GDP in the country and revenues of accommodation services. The paper continues by discussing the results which revealed that there is a significant relationship between the number of events in MICE tourism and GDP of Slovakia. Apart from this, the results also show that there is no significant relationship between revenues of accommodation establishments in Slovak republic and average expenditure on trip for a business purpose. Lastly, this study presents an overview on the MICE tourism in Slovakia taking research results.

Keywords: MICE tourism, COVID -19, GDP

JEL classification: Z32, C02, E44, A10

1 Introduction

MICE tourism as a shortterm for meetings, incentives, conferences, and exhibitions, faces due to a pandemic situation several significant challenges. The year 2019 represents a steppingstone after which the MICE industry will probably never be the same due to the COVID-19 pandemic situation. This fact gives us an opportunity to

reflect the previous years in Slovakia of meetings data which could be useful in terms of new thinking how to move forward in post – pandemic reality (ICCA, 2020).

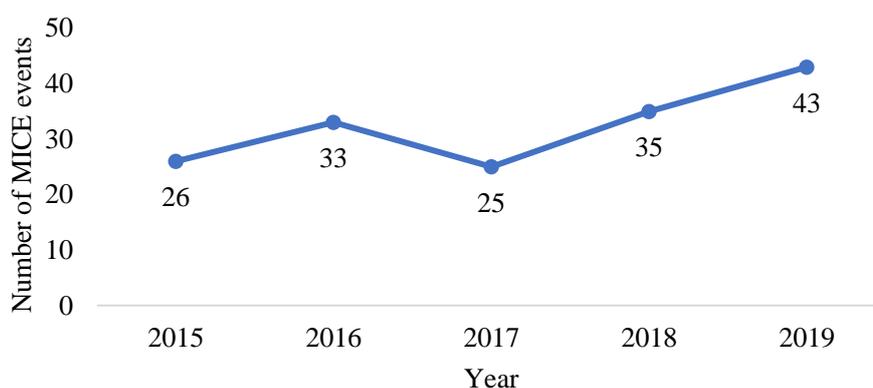


Fig. 1. Total number of international association meetings 2015 – 2019 in Slovakia
Source: ICCA, 2020

Figure 1 shows an increasing number of international events from 2017 in Slovak Republic. The statistics of events in MICE industry collects the global community and knowledge hub for the international association meetings industry ICCA – International Congress and Convention Association. To conclude, ICCA provides regular information from the field of MICE, compiles rankings and creates a database of international meetings. Data shown in Figure 1 consist only of those meetings that meet ICCA’s stringent assessment criteria, which means rotating between at least 3 countries, have a proven attendance of at least 50 participants and are held on regular basis.

It is important point out that Slovakia is attractive for the needs of this type of tourism due to its location in Central Europe, membership the EU and Schengen, good transportation accessibility and political stability. The Slovak Tourist Board (Slovakia Travel) is aware of the MICE segment importance and that is the reason why the Department of Congress Tourism was created in September 2009 focused on presentation Slovakia as a destination of congress tourism (Danielová, 2017).

However, in comparison of destination performance in attracting international meetings, it is important to emphasise that Slovakia is not a leading country in MICE tourism, but its performance has increased throughout the years. According to the latest data Slovak republic occupied 59th place (with 43 events) in the ranking of the most popular congress destinations that the International Congress and Convention Association (ICCA) compiles every year. In comparison to V4 countries (Poland -19th place with 213 events, Czech Republic - 24th place with 171 events and Hungary -36th place with 111 events), Slovakia is ranked the worst (ICCA, 2019).

1.1 Introduction to MICE tourism in Slovakia

MICE tourism belongs to an important part of Slovak tourism. This fact confirms the Slovak Development Strategy until 2020 where the congress tourism is defined as the one of the central forms of tourism for which has Slovakia the best conditions (Ministry of Transport, 2013).

The latest data show the situation of MICE tourism in the year 2019, which was the last year before this form of tourism was converted into online events because of global pandemic situation.

From the geographical point of view 34,7% of events are held in Bratislava region (SO SR, 2020). Bratislava belongs to the one of the most significant centres of MICE tourism thanks to its accessibility, innovation, excellence in execution and accompanying infrastructure or services, such as transportation system and accommodation which are key factors for successful events.

The latest data also show that most of the events in Slovakia (64,7%) are a one-day thing. Of course, there are also events which last 2 days (23,9%), 3 days (8,3%) and more than 3 days (3,2%) (Ministry of Transport, 2020).

Another quantification important to mention is diversification according to number of attendees and season. 91,8% of attendees of events which took place in Slovakia consisted of 50-249 people. The most events (29,7%) were held in the second quarter of the year.

This paperwork presents a brief overview of MICE tourism in Slovak Republic, evaluates its development and importance, and analyses its impact on the economy of the country.

1.2 Literature review

It is important to highlight the fact that organisation of MICE tourism events is attractive and economical interesting for hosting countries, cities, agencies and business entities because this form of tourism brings more economic benefits than just the consumption of primary services. Consumption of specific services related to MICE tourism includes professional program of congress, accompanying program and wide range of intermediated personal services (Novacká et al., 2010).

There are many previous studies that researchers have done in this sector. Here is a short overview of the most relevant ones in relation with economic impact.

The first article is by Fan (2017) where he analyzed the development of MICE industry to promote regional economic growth. The results of empirical research show that the development of the exhibition industry can promote the regional economic growth through studying the relationship between comprehensive economic benefits of MICE industry development and the GDP increasing.

Bradley et al. (2002) deal with the economic impact of MICE tourism. According to them the tourists of meeting events are major users of the entertainment and accommodation facilities of the locations they visit, and they spend more money on an average in comparison to leisure tourists. They emphasise that the potential for direct and indirect job creation in relation with MICE industry is high. Following this fact,

they highlight the importance and growth of this form of tourism which is reflected by the construction of centres and buildings for conferences and conventions which are not only held in the major cities of the world but also increasing in secondary and tertiary tourist cities and locations.

Dwyer and Forsyth (1997) in their research paper discuss issues related to the economic significance of MICE tourism. They describe MICE sector as an important generator of tourism expenditure, investment, foreign exchange earnings and employment, however, the economic significance of MICE tourism remains under-researched because of lack of data available for the estimation of magnitude of these effects.

2 Methodology

To understand better the problematics of MICE tourism is important to understand that this form of tourism is a multifaced industry. Its activities require, to a varying extent many different players such as transport, accommodation, provision of pre- and post-conference tourist opportunities, specific venues-purpose built centres and hotels, services of professional conference and exhibition organisers, catering services, social programs for delegates and attendees, specialized technical support (f. e. audio-visual services) etc.

Unfortunately, there are no detailed data available which would quantify each player in MICE tourism mentioned above. Another point is, that data obtained from the national statistics consists only of congress tourism, which is a part of MICE tourism. Therefore is important to understand that part of the conducted analyse in this paper relates to congress tourism which is a part of MICE tourism.

When it comes to processing these data for the purpose of analysis is important to emphasise that this study used secondary data to collect information and construct findings. The analysis process was based on the objective of this study which is to analyse and identify economic impact of congress tourism as a part of MICE sector in Slovakia with regard on GDP and revenues of accommodation services.

Important information necessary to mention is that we processed the most detailed available statistical database that reflects the present condition of MICE tourism in Slovakia. The Ministry of Transportation and Construction of the Slovak Republic as well as the Statistical Office of the Slovak Republic probably have more detailed information which are unfortunately not publicly available.

The required data for the purposes of this study were collected for a period of 5 years (depending on a variable). The variables used in this study include GDP per capita, average expenditure on trip for a business purpose and number of events in MICE tourism. These variables are assessed with the help of correlation and regression analysis to identify the impact of tourism towards the GDP in the country.

Assuming that combined economic benefits of the MICE tourism contribute to GDP growth, there is a correlation between these two parameters and the linear correlation function is as follows (Fan, 2017):

$$Y_t = \beta_0 + \beta_1 * X_t + \varepsilon_t$$

Where Y represents a GDP per capita in Slovak Republic in a year t and X is a economic benefit as a result of MICE tourism expressed through number of events generated in MICE tourism sector in a year t, ε is error term.

However, the process of obtaining all relevant data was really complicated because our national statistics cover only 5 years' time which can be a problem, especially in the cases of trying to do more in-depth study analysis.

We set up 2 hypothesis which can help us to reach our objective:

- Hypothesis 1: There is no relationship between the GDP and number of events in MICE tourism.
- Hypothesis 2: There is no relationship between revenues of accommodation establishments in Slovak republic and average expenditure on trip for a business purpose.

3 Main findings

The analysis of MICE tourism in Slovak Republic consists of all accessible data through variables such as, average expenditure on trip for a business purpose and personal purpose and number of events generated in MICE tourism and GDP per capita.

First, we analyse if there is a relationship between GDP per capita and number of events which are considered as international in Slovak Republic.

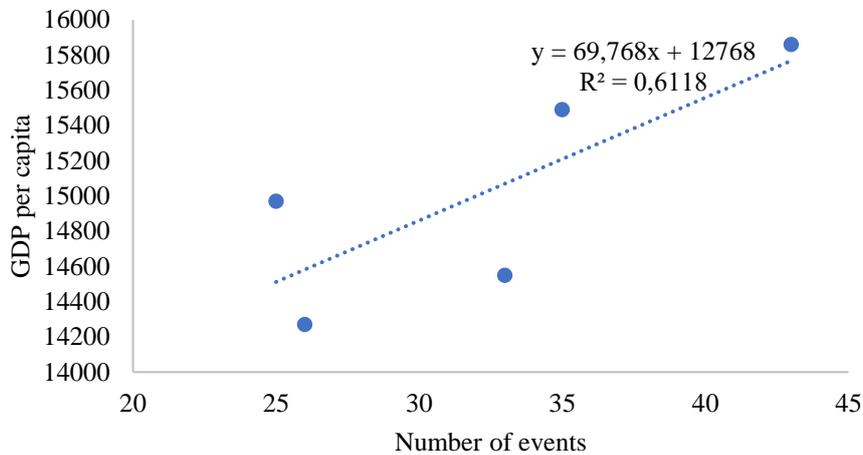


Fig.2. Scatter chart of GDP per capita and number of events in Slovak Republic (2015-2019) Source: ICCA, Eurostat

From the scatter graph above we can see that there is a clear positive correlation between GDP and number of events in MICE (F-statistics = 7,93; t-statistics = 2,82; p-

value = 0,067). To be more specific, more events realized in MICE tourism bring together more participants who have the potential to generate further expenditures. Organisation of these kind of events brings benefits not only to organisers and hosting countries, but also to all secondary business entities which are not in directly part of the whole process. Events related to MICE tourism are also a way to promote the cities or countries that host them.

Thanks to conducted correlation and regression analysis, we can sum up that our first hypothesis is rejected. Therefore, we can say, that events of MICE tourism have highly positive impact on gross domestic product per capita in Slovakia.

Relationship between the GDP per capita and number of MICE events		
	Number of MICE events	GDP
Number of MICE events	1	
GDP	0,78	1

To accomplish the next objective and analyse the second hypothesis we have decided firstly to compare the average expenditures of Slovak citizens on a trip for personal and business purpose in Slovak Republic. Our goal is to verify that expenditures for a business purposes are higher in comparison to expenditures for a personal purpose (Novacká, 2010). Graph 2 reflects the mentioned expenditures. These data were collected for a period of 10 years (2010-2019). Before analysing the following data it is important to mention the fact that expenditures on a trip for business purpose are not explicitly the part of MICE tourism, however, they can be partially a part of congress tourism as a part of MICE in the case, the attendees travel for congresses, conferences or seminars. Moreover, these data are the only available data which we can take into consideration while analysing the MICE activities from the economic point of view.



Fig. 3. Average expenditures for a business and personal purposes of Slovak citizens in Slovak Republic Source: Datacube, 2020

Thanks to graphical representation of expenditures, we can confirm the fact, that expenditures on a trip for a business purpose has been higher than expenditures for a trip for a personal purpose with exception of 2 years (2014, 2017). The reason why people spend more money on their business trips is caused simply by the very fact that while making a business trip, an employer is responsible for these expenditures. We verified this hypothesis by paired t-test (t-statistics = 3,25; p-value = 0,01), which showed statistically significant difference in means of variables.

Following this fact, our further objective was to study the relationship of average expenditures for a business purpose of Slovak citizens and revenues of the accommodation facilities generated by the residents of the country. Figure 4 reflects the relationship between these two variables. The results indicate a slightly positive relationship between the average expenditures of Slovak citizens and the revenues of accommodation facilities generated by Slovak citizens, however this relationship is not statistically significant (F-statistics = 1,78; t-statistics = 1,33; p-value = 0,24).

A significant benefit of MICE tourism in relation to accommodation sector lies in its time and organisation of events, because the season does not play an important role here. It's popular among accommodation service providers as it successfully fills hotel capacities during off-season which brings positive economic benefits to hotels through the expenditures of business guests.

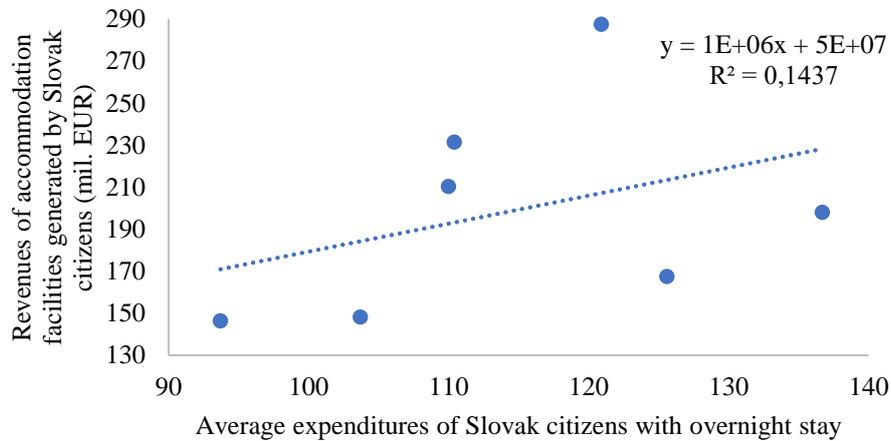


Fig. 4. Scatter chart of revenues from accommodation services and average expenditures for a business purpose with overnight stay in Slovak Republic (2015-2019) Source: Datacube, 2020

Relationship between the revenues of accommodation facilities and average expenditures for a business purpose with overnight stay

	Avg. expenditure	Revenues
Avg. exp. for a business purpose with overnight stay	1	

Revenues of accommodation facilities generated by Slovaks	0,38	1
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Last of all, we can reject the first H_0 hypothesis. Our results show that there is a significant relationship between the number of events and GDP of the country. However, we cannot reject the second H_0 hypothesis of non-existing relationship between average expenditures of Slovak citizens with overnight stay and revenues of accommodation facilities generated by Slovak citizens. since p-value of regression is greater than significance level.

4 Conclusion

Thanks to the results of conducted analysis, we can sum up that the role of MICE tourism in Slovak Republic is very important in the context of economic benefits resulting from this form of tourism. This fact confirms the future in the MICE tourism in Slovak Republic. The plan of National Congress Center of Slovak Republic is being prepared. The realization of this type of institution has the potential to increase economic benefits of MICE tourism of our country and raise the international awareness in MICE tourism world.

The results of conducted correlation analysis in this study show that there exists a strong relationship between the economic growth of our country expressed through the GDP per capita and the number of events in MICE sector.

Stemming from the second correlation analysis which studies the revenues from accommodation services and average expenditures for a business purpose with overnight stay in Slovak Republic we can sum up that there is no significant relationship between these variables.

MICE tourism belongs to economic oriented type of tourism (Novacká, 2010). This fact we can confirm by obtained data where we compared the average expenditures of Slovaks for a personal purpose trip and business purpose trip. The results show that in most of our time the expenditures of businesspeople have been higher which is a typical feature of this form of tourism because attendees of congresses are demanding guests with high purchasing power. They need a provision of all necessary conditions for quality work, but also for quality leisure time.

In the context of MICE tourism development in Slovakia we can summarize several challenges which faces this form of tourism. The most important one is that for the purposes of further analyses and further formation of strategic goals is important to improve the statistics regarding MICE tourism in Slovakia. We have been struggling a lot to obtain access to any kind of data specialized on MICE tourism. ¹

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Economic Damage to the State due to unpaid Taxes and Levies

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Abstract. In my contribution, I focused on issues that are directly related to tax fraud, tax evasion and tax avoidance. The area can be described as an abuse of the tax system, which in its opinion is a real reflection of the behaviours of tax subjects in a specific tax practice. As a result of this procedure, the tax revenues of public budgets are reduced, as the collection of taxes decreases from year to year compared to the estimates of the tax administration in most EU Member States. Tax evasion due to fraudulent practices causes economic damage to individual states.

Keywords: economic damage, taxes, levies, multinational companies

JEL classification: H21, H24, H26

1 Introduction

Tax planning represents the optimization of tax and contribution obligations in accordance with the relevant tax regulations. Taxes in Slovakia are divided into direct and indirect. Income and property taxes in particular are direct. Indirect are those that are already included in the price of goods, such as excise duties or value added tax. In addition to taxes, the tax burden on entrepreneurs is also affected by the levy burden.

When we talk about tax optimization, we mean mainly income tax optimization. An important role in income tax taxation is played by the tax rate, which is currently 15%, 19% and 25% for natural persons according to the amount of the tax base, and 15% and 21% for legal entities (with exceptions in law). However, the final tax paid by the state is also affected by the creation of the tax base, the eligibility of tax expenditures, the possibility of claiming a tax loss, exemptions and tax relief, etc. The much higher tax burden than the direct tax rate is due to wage and income levies. The number of contributions affects not only the net salary of the employee, but also the price of the employer's work. The levies are paid from the salaries of employees in enterprises or are paid by natural persons engaged in business from their income. Employee

contributions in 2021 represent 13.40% of his gross salary and employer contributions represent 35.20%, so the total payment from wages is 48.60%.

Not only large multinational companies, which mainly use the differences in tax regulations of different countries, but also small Slovak companies can optimize taxes. Legislation provides entrepreneurs with a number of options for optimizing the amount of their tax liability within the limits of the law. A necessary condition for tax optimization is to know the possibilities that the law allows. We divide tax optimization into three basic types: legitimate tax optimization, aggressive tax optimization and tax fraud.

Legitimate tax optimization can also be understood as a set of tax tricks, how to pay the smallest possible amount of taxes from the entire tax basket, which the company is obliged to pay to the state according to tax laws. Although in recent years Slovak tax entities have made significant progress in using legitimate tax optimization, there is still potential for the use of reserves in this area. The positive effects of tax optimization are particularly effective in the long term. In addition to the direct impact on increasing the profit of tax subjects, tax planning also contributes to reducing the risks of the corporate economy in a market environment.

International tax planning through multinational holding structures is a long-term and detailed work consisting in the consideration, preparation and subsequent implementation of individual transactions of companies in the group. International tax optimization is widespread mainly through the structures of holding groups, which often represent the best conditions for this activity. Holding groups also take advantage of tax havens to some extent to reduce their tax liability. The basic starting point of tax planning is to set the holding company's tax goals. Subsequently, the economic holding, general tax assessment, subsequent optimal tax setting and elimination of individual risks are defined in individual holding structures and their transactions.

International tax optimization is usually carried out through the use of double taxation treaties. The savings are achieved by more favorable taxation under the Treaty in one country and non-taxation in another. Typical tools and methods of optimization include: foreign trade, holding structures, licenses, intellectual property, loans, financing, consulting services, trusts, foundations, partnerships, etc. (Petrovič, P. et al., 2002).

Aggressive tax optimization is most often the procedure of a taxpayer who did not technically violate any provision of the law, but by his actions reached a state that is contrary to a principle of justice, abused the law, and thus the tax advantage achieved by this action is illegitimate. Aggressive tax optimization lies between legitimate tax optimization and tax fraud. Perhaps the simplest example of aggressive tax optimization is selling something at a non-market price to gain a tax advantage.

Tax evasion due to fraudulent practices causes economic damage to individual states. In essence, damage represents the value expressed in the money of the damaged property, health or rights of specific entities, which may be natural or legal persons having a certain relationship to the object of damage. Very often there is damage in business to natural and legal persons, ordinary citizens, but also the state. Damage to the state can occur in various ways, and these certainly include damage to the state on unpaid taxes and levies. Small businesses, small, medium and large companies, as well

as multinational companies, can take part in this damage. Multinational companies can use different systems to avoid paying taxes in countries with huge incomes. As a result, public services are either underfunded or must be funded by other low-income taxpayers. At the same time, it contributes to increasing inequality around the world.

2 Methodology

This paper examines the economic damage incurred by the state in unpaid taxes and levies in Slovakia and in the countries of the European Union. To obtain the necessary information and data, a survey method was used through statistical data obtained from Crime Statistics in the Slovak Republic, Ministry of the Interior of the Slovak Republic. The resulting data show, based on a comparison of the development of aggregate numbers of economic crime in Slovakia, that the number of crimes gradually decreased in the years 2008-2019. A positive trend is also the development of clarification in the crime of money laundering.

3. Current state, essence and development in the field of payment of taxes and levies in Slovakia and in the world

Tax fraud distorts the business environment and is also a threat to public finances. Tax fraud is part of economic crime. Tax fraud is most often committed on value added tax, income tax and excise duties. Due to the negative consequences of tax fraud, countries are trying to combat it. It is also the case in the Slovak Republic, where tax fraud arises in the business of Slovak entities, but also international companies.

The fight against tax fraud, whether it takes the form of tax fraud, tax evasion or tax avoidance, has become

a real global challenge not only for the EU and its Member States, but in a way for the whole world. In essence, these are various forms and ways of abusing tax systems both within the EU and abroad.

From the point of view of EU law, the area of combating the abuse of the tax system is undoubtedly a very topical issue and at the same time a very complex and sensitive topic. This applies not only to indirect taxes, in particular VAT, but also to direct taxation. In the implementation of tax fraud on VAT, there is ultimately a tax evasion on this tax and thus a loss of state budget revenues. However, this leakage does not necessarily have to be the result of the implementation of tax fraud by the taxable person within the applicable system of VAT application, ie which is the object of interest of criminal legislation.

In today's globalized economy, the biggest problem of states is multinational companies and their sophisticated structures of international tax planning, which intervene in several tax jurisdictions. The purpose of these structures is to circumvent the legislation of the State concerned and to obtain a tax advantage in the form of non-payment of tax or reduction of the tax base. Although this circumvention of the legislation will not violate the legislation, it will achieve a tax advantage that is contrary

to the principles of taxation and at the same time contrary to the intentions and objectives of the tax legislation.

The best-known tax structure currently used by many multinational companies in various variants is called "Double Irish Dutch Sandwich".

The basic scheme of this tax structure consists of two subsidiaries incorporated under Irish law. The first is a tax resident in a tax haven (since, under Irish tax law, only a legal entity which has its place of effective management in Ireland is a tax resident), and the second is a Dutch subsidiary. The tax haven company owns the intellectual property rights from the parent company, which licenses the other Irish company, which is tax resident in Ireland. This company generates revenue from the sale of internet advertising or technology products from the region, but its tax base is low as it pays royalties, payments for services, etc., which are tax deductible expenses under Irish law, to companies from a tax haven. The Dutch subsidiary is used to avoid paying Irish withholding tax on these payments. As a withholding tax is not applied to most payments under the double taxation agreement between the Netherlands and Ireland, the Irish company pays selected payments for the Dutch company's royalties. It in turn pays the license fees of an Irish company established in a tax haven, but since the tax can no longer be taxed, this income goes directly to accounts in a tax haven, where no income tax is levied. As a result of this tax structure, for example, Apple paid about \$ 130 million in tax on its foreign income in 2010, which was \$ 13 billion that year (Böll - Dettmer - Dohmen - Pauly - Reiermann, 2021).

Google also accounted for only 3.2 percent of tax profits in countries outside the United States in 2011. At the same time, revenues in European countries, in which the corporate income tax ranges from 26 to 34 percent, contributed the most to this profit. For example, the UK market accounted for 11 percent of Google's total revenue from outside the United States. In the UK, Google had revenue of \$ 4.2 billion, but paid only \$ 9.6 million in income tax, although corporate income tax is set at 26 percent in the UK. At the same time, Google has an operating margin of 28 percent globally and it can be assumed that it has a similarly high margin in the United Kingdom.

Illegal tax evasion, in general, consists of illegal agreements where the actual amount of tax liability is hidden or ignored by the taxpayer, that is, the taxpayer pays a lower tax than is liable, by hiding income or information from tax administrations. In addition to these concepts, it is possible to look at tax evasion as "tax fraud", which is an intentional illegal tax evasion, which can be sanctioned by criminal law (Huba - Sábo - Štrkolec, 2016).

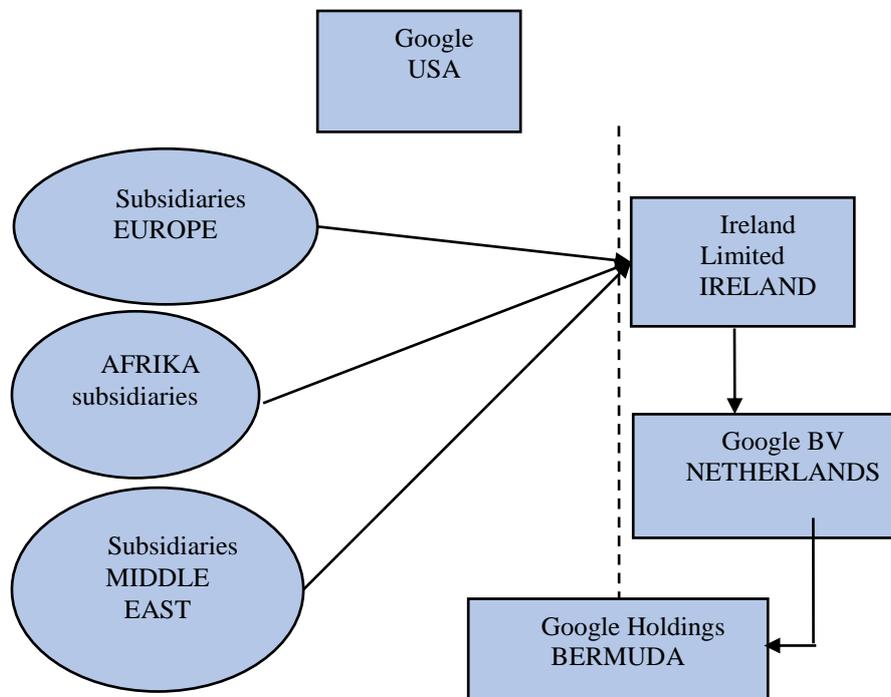


Figure 1 Double Irish Dutch Sandwich. Google Tax Monitoring
Source: Own processing

The double Irish sandwich, which makes Google avoid taxing work that way, will establish the Irish company Google Holdings in Bermuda, which provides services and marketing. The management is based in Bermuda, so for the purposes of Irish tax law it is a Bermuda company. It will also create an Irish subsidiary, Ireland Limited, which has the rights to license know-how for all Google subsidiaries in Europe, Africa and the Middle East. Payments go to her to use the intellectual property license. However, Ireland Limited does not send royalties to Bermuda as it would have to pay withholding tax in Ireland but will move them to an EU country that will treat the Bermuda payment differently. Therefore, the payments go to the Dutch company Google BV. These payments are tax-free because both countries are part of the European Union. The Dutch Google BV then moves them to Google Holdings in Bermuda, again without withholding tax (for Dutch taxpayers, it is an Irish company and not a Bermuda company). Income tax in Bermuda is zero. While U.S. tax law requires taxation on the payment of remittances abroad within a group, for U.S. law purposes, Irish and Dutch companies will not be corporations but only Google divisions, so no withholding tax is required. As a result, for tax purposes in the USA Ireland Limited and Google BV do not exist, but for Europe they do. For Ireland, Google Holdings is a Bermuda company,

but for the United States, it is Irish. Ultimately, Google (USA) effectively 2 to 8% tax on foreign profits. Other tax obligations did not seem to exist.

According to the OECD, the most common way is to reduce the tax base ("tax base erosion") and transfer profits ("profit shifting") of taxpayers. These are complex legal structures and acts aimed at transferring profits from the state where they were generated to a state with a low or zero tax rate. In particular, taxpayers take advantage of situations not covered by law which arise as a result of the interaction of tax legislation of two or more states.

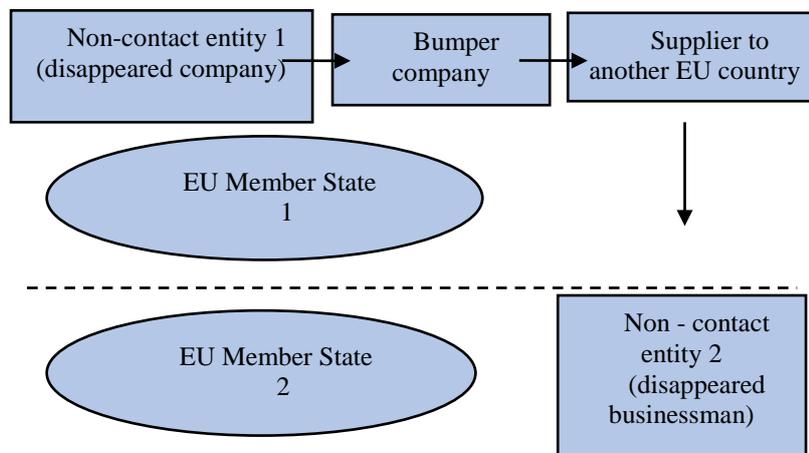


Figure 2 VAT fraud with a missing trader
Source: Own processing

The biggest tax evasions in the field of value added tax (VAT) are carousel fraud (carousel fraud, circular fraud, Missing Trader Frauds). Organized groups usually use cross-border trade in the European Union, where The term "missing trader" refers to the fact that the trader disappears and with it the VAT he was supposed to pay to the state disappears, which is why missing traders are also referred to as white horses. a complex type of fraud where goods are traded in a chain, where no tax is declared or paid at one point in the VAT chain and the relevant economic operator ceases to exist or the company cannot be traced.

3 Results and Discussion

- International tax evasion is a series of steps by taxpayers to achieve their goal of exploiting differences in the effective tax burden across countries, as well as other benefits from cross-border income tax regimes, to reduce their tax burden and the overall tax burden on all connected persons. (Huba- Sábo - Štrkolec, 2016). In the professional literature of American origin, the term tax shelter is

used to describe these steps. Taxpayers who take such steps are building a "shelter" under which they can "hide" from tax liability. According to Graetz, a tax shelter is "an agreement made by very wise people that would be very stupid without tax implications" (McMahon, 2003). An analogy of illegal tax evasion in the case of shelter before tax is the so-called abusive tax shelter. This concept is a well-established concept in the Anglo-American environment, being "primarily based on the common law doctrine of the economic substance of the transaction" (Department of the Treasury, 1997). In terms of the substantive proximity of these terms, the term tax shelter and illegal tax evasion will be used promiscuously for the purposes of this monograph. The defining features of illegal tax evasion in the US legal environment were characterized by Bankman (2004) and the fact that it is a tax-motivated transaction, unrelated to the taxpayer's normal business activities, in a formalistic interpretation of the law creating a tax loss in excess purpose of the law. At present, business entities have many options for optimizing their tax obligations. The following methods are most commonly used (Korb, 2005):

- income shifting, which is the arrangement of transactions so as to distribute taxable income, tax expenditure and tax credit among taxpayers so that they have the lowest possible tax liability,
- exemption, which is a reduction in the tax liability through an exemption for certain categories of taxable income,
- deferral, which is the deferral of tax liability by shifting income to future tax periods, for example in the form of an investment against tax expenditure that will not be repaid in the future,
- conversion, which is the conversion of taxable income into income which is in some way tax-advantaged,
- Leverage, which is the financing of business activities through borrowed funds, which allows for an increase in tax expenditure.

At the same time, it should be further noted that debt in combination with exemption, conversion or deferral is referred to as tax arbitrage, which results in a tax loss (or tax expense) more than the actual economic loss.

According to the OECD, the most common way is to reduce the tax base ("tax base erosion") and transfer profits ("profit shifting") of taxpayers. These are complex legal structures and acts aimed at transferring profits from the state where they were generated to a state with a low or zero tax rate. Taxpayers take advantage of situations not covered by law which arise as a result of the interaction of tax legislation of two or more states.

Table 1 Groups of economic crimes in the Slovak Republic 2008-2019

Crimes	Number of detected	Count clarified	Damage in thous. EUR	Average damage in thous.EUR	Degree of clarity
					in %
Crimes	1266	203	131346	104	16
money laundering	53155	33151	1635796	31	62
Tax offenses	57260	30393	1590934	28	53
Frauds	3015	552	274408	91	18
Bankruptcy crimes	2184	604	1434991	657	28
Selected economic crimes	116880	64903	5067476	43	56

Source: Own processing

According to individual groups of economic crimes, in the years 2008 to 2019 there were the most tax crimes that caused damage to the state, up to 1,635,796 thousand. EUR. The number of detected tax crimes was 53,155, of which only 33,151 were solved. The rate of clarification of these crimes was 62%. The second group of crimes that caused the most damage was tax fraud. These caused damage to the state in the amount of 1,590,934 thousand EUR. . The clarity of these crimes was 53%. This was followed by selected economic crimes (damage of EUR 1,434,991 thousand), bankruptcy crimes (damage of EUR 274,408 thousand) and criminal offenses of money laundering (damage of EUR 131,346 thousand), depending on the amount of damage caused.

Table 2 Overview of economic crimes in the Slovak Republic 2008-2019 (in thousands of EUR)

Year	Detected crimes	Clarified crimes	Clarity in%
2008	16974	7513	44
2009	19518	8739	45
2010	16781	7338	44
2011	18145	8137	45
2012	16681	7272	44
2013	19218	7995	42
2014	1745	8060	46
2015	16661	7375	47
2016	14895	6994	47
2017	14460	7108	49
2018	13515	6784	50

2019	13326	6757	51
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Source: Own processing

In the years 2008 to 2019, according to Table 2, the clarity of economic crimes ranged from approximately 40 to 50%. This means that the damages enumerated in Table 1 are at least 2 times as high as indicated. This fact is also illustrated by Graph 1, which provides an overview of detected and clarified economic crimes in the Slovak Republic in the years 2008 to 2019.

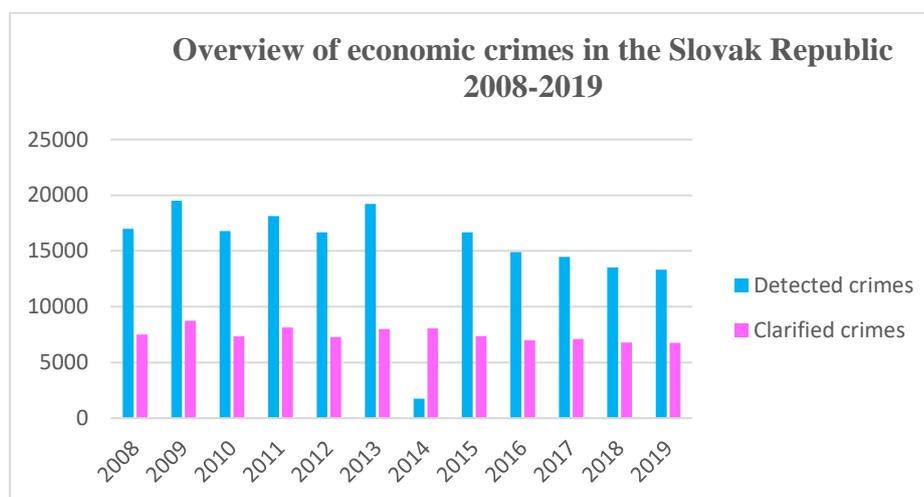


Figure 1 Overview of economic crimes in the Slovak Republic 2008-2019

Source: Own processing

Table 3 lists the most common types of economic crimes and the damage caused by individual tax subjects of the state.

Table 3 Overview of the most significant economic crimes by average damage (in thousands of EUR).

	Crime	Total damage in thous. EUR	Total number of detected	Average damage
1	Distortion. hosp. and business records	1 150 347,00	1 242	926,00
2	Machinations at ver. competitions, auctions	11 745,00	222	503,00
3	Breach of duty in the administration of foreign property	273 751,00	893	307,00
4	Fraudulent and guilty bankruptcy	22 756,00	93	245,00

5	Misuse of information in business. contact	10 863,00	45	241,00
6	Smuggling (§ 254)	9 807,00	69	142,00
7	Abuse of power by a public official	37 065,00	279	133,00
8	Damage to the EC 's financial interests	61 101,00	557	110,00
9	Legalization of proceeds of crime	131 346,00	1 266	104,00
10	Damage to the creditor	251 653,00	2 922	86,00
11	Theft of road shipments	1 284,00	15	86,00
12	Threat to hosp. secrets	4 080,00	52	78,00
13	Fraud (§ 221)	1 425 552,00	36 381	39,00
14	Violation of plant and animal protection	79 830,00	2 305	35,00
15	reduction of taxes, fees (§§ 276-279)	1 635 796,00	53 155	31,00

Source: Own processing

A comparison of the development of aggregate numbers of economic crime in Slovakia shows that the number of crimes gradually decreased. In 2014, 17,450 cases of economic crime were detected in the Slovak Republic, in 2019 it was only 13,326 cases (by 24% less, is by 4,124 cases). However, the current trends in the rate of clarification of economic crime are the opposite. The rate of clarification increased by 4.5 percentage points (from 46.2% to 50.7%). This positive development for Slovakia, however, is significantly influenced by the high level of clarification and frequency of tax crime (tax crimes accounted for up to 43% of the total number of detected economic crimes in 2019. It follows from the above that statistics contain a high number of tax crimes. Statistics on other monitored economic crimes show a low level of crime detection in Slovakia, with the level of detection falling to 40% for fraud crimes and up to 16% for bankruptcy crimes in recent years. obligations in the management of foreign assets) to 23%.

One of the few positive trends is the development of clarification in the crime of money laundering. Although it is one of the least numerous among those surveyed, its level of clarity has risen sharply in the last three years in the Slovak Republic (from 14% in 2017 to 33% in 2019). The average amount of damage in 2019 in Slovakia is also unusual, reaching up to 701 thousand. EUR.

Tax fraud distorts the business environment and is also a threat to public finances. Tax fraud is part of economic crime. Tax fraud is most often committed on value added tax, income tax and excise duties. Due to the negative consequences of tax fraud, countries are trying to combat it.

4 Conclusion

The international tax optimization of multinational companies has recently become the subject of intense international debate. There are currently several initiatives in the world that have a significant impact on international tax optimization. The most important initiative is BEPS (Base Erosion and Profit Shifting), which directly fights against multinational companies reducing their income tax base by exploiting loopholes in local tax legislation. This initiative is aimed primarily at multinational giants such as Google, Starbucks, Amazon and others, but ultimately the impact of BEPS will affect all international transactions. The BEPS initiative is mainly about changing the role of the tax administration. Its task will be to obtain a significantly larger volume of data from companies, which it will then compare and look for ambiguities. By analysing this data, the tax administration eliminates the need to actively look for suspicious companies that it should control. An example of such data acquisition is transfer pricing documentation and related reporting of business transactions between related parties. Multinational corporations as well as ordinary companies (even natural persons in Slovakia) must prove the correctness of transfer prices in more detailed assessments and declare transactions with related parties in tax returns. BEPS also places more emphasis on the so-called substance, is that the company is actually managed from the place where it is based. Significant tightening will also affect the procedures for assessing tax deductibility and the justified amount of costs associated with the use of licenses and trademarks. The assessed values of licenses will be tightened, which will have to be substantiated by expert opinions. Other steps that will change tax planning are the effort to tax income in the countries of their origin and the long-term revision of double taxation treaties. All BEPS-related activities mean that tax optimization will need to have significantly stronger foundations and greater emphasis will be placed on ensuring that tax planning is not the main goal of multinational corporate structures. However, well-established holding structures that meet the owners' primary non-tax objectives will be affected by higher administrative costs for BEPS.

Currently, the most frequently discussed economic topic is the reduction of budget deficits, which are the result of a pandemic recession. Central banks are being called upon to support the economy with cheap credit, as well as national governments, so as not to stop stimulating the domestic economy, which, of course, is already increasing their huge indebtedness. However, coalition governments then have no choice but to increase budget revenues only by increasing taxes and levies, which always causes social tensions in the country. In general, those who have income from anything should pay tax where they have "earned" income, which has not been the case, especially with digital companies. Until now, digital companies have shifted profits outside the countries where they were generated, where taxes were lowest, if at all. However, the problem is not only the payment of taxes, but also on what basis, as their business is an online way, without the possibility of a legal way of calculating it. The solution could be a lower tax rate on revenues, which would be paid to the state budget in the state where the digital company generated revenues. The European Commission has not yet been able to agree with the US administration on the conditions for the introduction of the digital tax, also because it is said to have "threatened" the introduction of renewed

customs protection measures for the export of European products to the American continent. However, the pandemic has accelerated the European Commission's efforts to seek financial resources to cover the aforementioned deficits in the Member States of the Union, including the introduction of a Europe-wide digital tax, which has not yet been the case.

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Quality Adjusted Labour Input

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Abstract. The aim of this paper is to evaluate the contribution of quality adjusted labour input to increase of labor productivity in Slovakia. The development of productivity is compared regarding the qualitatively adjusted input of work and without considering the quality factor. The aim of these comparisons is to point out possible shortcomings in the current measurements of productivity, or at least the individual components that enter its calculation. The change in the methodology in the calculation of the contribution, considering the quality of work, is more adapted to current trends in the labor market and especially to its future development regarding growing demands on the qualitative aspect of work and increasing share of work with a high level of skills needed to perform it. This is influenced, among other things, by the development and greater involvement of information technologies, digitalization and robotization, the necessary complement of which is the adaptation of the skills of the workforce, a change in their structure and an increase in their level.

Keywords: Labour productivity. Quality adjusted labour input. Quality factor.

JEL classification: O 40

1 Introduction

The slowdown in economic growth is a phenomenon in recent decades affecting predominantly developed countries of the world. One of the theories that has been discussed for a long time is the impact of declining productivity on economic growth. According to an OECD study, this phenomenon is a global phenomenon affecting most developed economies. On average, in more than 17 advanced economies, productivity growth has fallen to less than 1% per year in the last decade, less than half the rate seen in the last 30 years. In the medium term, sustainable economic growth equals the sum of productivity growth and the growth rate of labor supply. For this reason, the

slowdown in productivity growth will each be reflected in a slowdown in sustainable GDP growth (OECD, 2018).

2 Theoretical Perspectives on Productivity Growth

This finding is particularly striking in the face of the completely opposing expectation that advances in technology, especially in artificial intelligence and robotics, are set in such a massive increase in labor productivity that vast sections of some sectors of the current workforce will not be forced to work longer, on the contrary, there are concerns about redundancy, the replacement and automation of manpower and labor shortages. There is still not enough information, and it is not entirely clear where (in which sectors) this replacement is most likely, when it is likely to occur and to what extent it will be a good or bad thing for the whole economy. However, the question is why this is not yet visible in labor productivity statistics.

It emphasizes that the higher the level of education of the labor force, the higher the overall productivity of capital, because the more educated are more likely to innovate, and thus affect everyone's productivity. In other models, a similar externality is generated, because increased education of individuals increases not only their own productivity, but also the others with which they interact, so that overall productivity increases with increasing average level of education (Lucas, 1988). The study on economic growth and human development offers the complementary view that technical progress depends on the level of research and development in the economy. By investing labor and capital in research and development, the company is able to improve not only its own profitability, but also the productivity of research and development, which consumes its production. Several empirical studies have shown the positive impact of education on economic growth at the macro level, varying in size according to the level of education and the specific macro space model adopted (Ramirez, 1997).

Other growth studies also assume that the formal skills and experience contained in the workforce are a form of (human) capital. On one hand, it could be argued that human capital is subject to declining income, so that a highly skilled and skilled workforce would have higher income levels in the long run, but not necessarily a consistently higher rate of income growth. On the other hand, investment in human capital (eg expenditure on education and training) could have a more lasting impact on the growth process if high skills and training go hand in hand with more R&D and faster technological progress, or if adoption new technologies are facilitated by a highly skilled workforce (Bassanini, 2002).

According to Jackson (2019), the critical question is how politics should respond to this situation. The conventional response so far has been to find available conditions - technological, fiscal, monetary - to sustain growth regardless of price. The ongoing "rescue regime" relied on the assumption that, in addition to appropriate policy incentives, new technological discoveries would come and productivity growth would resume. Candidates for the so-called "rescuers" are different. For some, it will be innovation based on investment in clean, low-carbon technologies that is needed to

tackle climate change, climate change and offset resource depletion. For others, it will be innovations based on the coming digital revolution: increased automation, robotics, artificial intelligence. So far, however, none of the productivity gains expected by these technologies have been reflected at the macroeconomic level, and this future world could lead to a complete replacement of the workforce and levels of inequality.

2.1 Factors affecting productivity

Measuring productivity is a key element in assessing living standards. A simple example is per capita income, probably the most common standard of living: per capita income in the economy varies directly according to one measure of labor productivity, namely value added per hour worked.

Multifactor productivity (MFP) affects economic growth through factors that are not attributable to capital or labor, but through technological change or the improvement of knowledge, methods and processes.

In terms of growth factors, it is necessary to examine more deeply the work, its volume and quality. The OECD (2001) states that the contribution of labor should reflect the "time, effort and skills of the workforce". A common standard for entering work is the use of hours as a unit of measure. However, the time dimension of the work does not reflect its quality (skills). However, these are captured in the aggregate productivity factors.

Labor productivity reflects how efficiently the workforce is combined with other factors of production, how many of these additional inputs are available per worker, and how quickly technical changes are taking place. As a result, labor productivity is a good starting point for analyzing some of these factors.

2.2 Labour Input

Work remains the most important input into many production processes. From the point of view of production analysis and at the same time ignoring differences in quality, the input force of labor is most appropriately measured as the total number of hours worked. However, several statistical problems arise in connection with the measurement of hours worked. The quality of the hours worked estimates and their degree of international comparability are therefore not always clear.

According to ONS study, labor income and labor shares should reflect the compensation paid to the labor force from the producer's point of view, including wage and salary supplements such as employers' contributions to social security payments. However, as with "hours actually worked", many seemingly straightforward concepts raise many conceptual and empirical questions about their measurement. This concerns issues such as the treatment of non-wage earnings for employees (eg stock options) or the treatment of the self-employed (ONS, 2007).

Because a worker's contribution to the production process consists of his "raw" work (or physical presence) and services from his human capital, one hour worked by one person does not necessarily represent the same amount of input working time as one hour worked by another person. There may be differences in skills, education, health and professional experience, leading to large differences in the contribution of different

types of labor. Differentiation of labor input by type of skills is particularly desirable if we are to capture the effects of changing quality of work on output and productivity growth. However, explicit differentiation is data and research intensive. Minimum time series of hours worked broken down by one distinguishing characteristic must be available, together with the corresponding statistics on average compensation broken down by the same characteristic.

2.3 Quality Adjusted Labour Input

Jorgenson et al. (1987) state that "When measuring labor productivity, labor input is traditionally defined in understanding the sum of all hours worked by employees, owners and unpaid workers. As a result, the same amount of work is considered an hour worked by a highly experienced surgeon and an hour worked by a newly recruited teenager in a fast-food restaurant. It doesn't matter who worked or what kind of jobs the workers held. All workers are treated as if they were the same. "

To estimate changes in productivity, the question is whether the composition of the labor force changes over time, whether there is an increase or decrease in the average quality of labor force inputs. According to most measurements, the quality of work has been and continues to increase. An increase in the average quality of work means that the adjusted labor input rate, which includes the quality aspect, would grow faster than the unadjusted labor input rate. As stated by ONS (2007), successful quality adjustment is equal to measurements of work in units of constant quality. Measuring consistently high quality labor input is interesting in several respects.

On the one hand, it provides a more precise indication of the share of labor in production. This can be usefully interpreted as one aspect in the formation of human capital. It is a step towards measuring one important aspect of the effects of "intangible investment" (Britain, 2007).

In the literature and in statistical practice, there are different approaches to differentiating labor input. The differences between these approaches are closely related to the measurement of "skills". One possibility is to assume a direct relationship between skills and occupations, to rank occupations according to their skill intensity, and then to use information on the distribution of hours worked in employment to derive differentiated rates of labor entry. This is, for example, the approach chosen by Lavoie and Roy for Canada (Lavoie, Roy, 1998), or the OECD (2001) for several OECD countries.

However, the assumption of capturing all relevant differences in skills when looking at occupations may not be correct. Other distinguishing features, such as age, health, or educational attainment, can reasonably be considered significant. Jorgenson et al. (1987) used up to five characteristics (age, education, class of workers, occupation, and gender) to cross-classify labor force entry into a detailed industry. Because different characteristics correlate, the resulting rate of labor composition reflects both the direct contribution of these characteristics to production growth and the interaction effects between them.

Another possibility is to use a small number of differentiation characteristics, but to choose them to minimize the correlation. This is the approach taken by the US Bureau

of Labor Statistics: hours worked are only cross classified according to education and work experience. Furthermore, there is no sectoral distinction. This reduces the effects of the interaction between variables and facilitates the identification of independent sources of change in quality of work (BLS, 1993).

Regardless of whether there are one or more distinguishing features, hours of highly qualified persons and hours worked by unskilled persons cannot simply be added to the aggregate rate of input labor - they must be weighted according to their relative productivity to take account of differences in skills. The theory of the firm states that under certain conditions (a firm is a price maker in labor markets and focuses on minimizing its total costs) a certain type of work will be hired up to the point where the cost of the next hour of work will be equal only to the additional income work generates. This equality means that for the rate of total labor input, individual labor inputs of different quality can be weighted by the respective relative wage or, more precisely, by the share that each type of work occupies in the total remuneration.

Thus, the growth rate of the total input adjusted for the quality of work L is measured as:

$$\left(\frac{d \ln L}{dt} = \sum_{i=1}^M v_i \frac{d \ln L_i}{dt}\right) \quad (1)$$

where L_i represents a specific type of work and where v_i is the share that the total type of work occupies in the total compensation of work (Britain, 2007).

We can notice that even if only a simple trait, such as a profession, is chosen to differentiate the input of the workforce, the information requirements are high.

Standard measures of labor productivity express the growth of output with regard to the volume of labor input, whether in terms of employment, the number of jobs or hours worked. The implicit assumption underlying this approach is that the workforce is homogeneous because it does not consider the composition or quality of the workforce (Acheson, 2011).

However, the workforce is far from homogeneous, and the "value" of hours worked, or marginal productivity varies significantly between workers. When measuring labor productivity, the most representative measurements of input power (labor contribution, labor input) are measurements adjusted for the composition of work (often referred to as "adjusted for quality" measurements). The contribution of quality adjusted labor input - QALI seeks to solve the erroneous assumption of work homogeneity and provides measures that explicitly recognize the heterogeneity of work by adjusting the volume of hours worked according to certain characteristics (Zealand Statistics, 2008).

Thus, there is general agreement that work as a factor of production is highly heterogeneous and varies in different dimensions. Improper consideration of different dimensions of work will result in an overestimation of overall factor productivity. The full work rate should therefore consider the characteristics of the workforce, such as working time, experience, education, effort, age and gender, in order to allow a more comprehensive assessment of the contribution of work. Depending on the focus of the research and the availability of data, it is possible to compile different indices of a well-

adjusted workforce. However, the creation of a measure that captures all these impacts requires a considerable amount of data, especially when dealing with data at sectoral level (O'Mahony, 2005).

QALI is therefore a conceptually more powerful method for use in productivity and growth accounting analyzes and is a useful tool for assessing human capital developments over time. It is used in conjunction with experimental estimates of capital services (e.g., Appleton, 2011) to generate multifactor productivity estimates (Acheson, 2011).

While the importance of differences in the quality and composition of labor inputs has long been recognized (Jorgenson, 1967), the increase in educational attainment in all OECD countries has increased the emphasis on the importance of considering the quality of labor inputs. In addition, the importance of the quality of the workforce has recently been emphasized in the context of the extensive use of ICT capital and the increased investment in additional resources (including skills) to support their expansion. Investing in the skills of the workforce is part of this additional investment, and therefore an assessment of the quality of the workforce is needed to distinguish between returns on ICT capital and returns on the labor force. Investment in ICT and education together are among the most important sources of growth at the level of industry as well as the whole economy (Keeney, 2009).

Measuring the skill dimension is particularly important in productivity studies, as workers with different qualifications will have different effects on productivity growth. A more complex level of labor, which corresponds to the skill level of the labor force, usually increases the share of labor income within the production function and reduces aggregate productivity. This helps to understand the factors that determine productivity growth. In addition, a comparison of adjusted and unadjusted labor input rates provides a measure of the corresponding change in the composition or quality of labor input (O'Mahony, 2005).

The concept of adjusted work considering quality has been introduced and incorporated in many statistical institutions into productivity measurements. Institutions, including the Australian Bureau of Statistics (ABS), the Bureau of Labor (BLS), the Bureau of National Statistics, and Canadian Statistics, have used this approach, but there are significant differences in specific concepts and methods (Acheson, 2011).

3 Methodology

In practice, estimating the labor composition index requires calculating the number of hours worked by each type of worker, as well as the weighting of the share of costs for each type of worker. Cost-share weights can be calculated either by observed wages or, as the BLS does, by replacing actual wages with imputed wages, where imputations are obtained from Mincer's standard wage regression. The key components for identifying different categories of workers are the equation with the Törnqvist index as the difference in the natural logarithm of consecutive observations, with weights equal to the average of the proportions of the factors in the corresponding years. The group must theoretically have a different output elasticity to other employees, which should be

demonstrated in the data by the wage difference for this group. In addition, working hours should change compared to other groups (Zealand Statistics, 2008).

A key requirement for the successful application of the workforce composition model is extensive skills measurement to distinguish hours worked between different groups. In similar studies, the theory of human capital has been used to address this situation. The OECD defines human capital as "the knowledge, skills, competences and attributes contained in individuals that facilitate the creation of personal, social and economic well-being." Human capital theory states that there is a positive relationship between wage levels, education and work experience. Education and training, which improve workers' skills and productivity, can be seen as an investment in human capital. In addition to assigning staff to qualification groups, each group needs to be valued to provide an indicator of their relative quality. At the international level, nominal wages play an integral role in adjusting composition as the best available, albeit imperfect, variable for weighting groups when adjusting their composition.

As soon as each species is given a weight, a composition-based labor force index can be compiled based on its share of total labor costs (wages). It would, of course, be naive to assume that wages are determined solely by one's skills. Factors such as discrimination, trade union bargaining, signaling, minimum wages, effective wages and non-compliance can jeopardize the validity of the use of wages as a measure of worker productivity (Turunen, 2006). This has a particular effect when the nature of these factors (trade union membership) changes over time. Other factors need to be considered, such as the short-term increase in labor shortages in the labor market with specific skills and the resulting impact on the wages of these occupations. As overseas case studies, such as the BLS study, have shown, there are measures that can be taken to control some of these factors.

In this work, we will derive the rate of labor input (LII - denominator of the labor productivity equation) using the chained Törnqvist index, in which the weights are based on the wage shares of the industry in the measured nominal income of the labor force. Assuming that cross-sectoral wage differences reflect differences in skills, this assumption is to adjust the composition of the series by a quality factor, as the weights will be comparably large for industries that pay above-average wages and, conversely, for industries that pay below-average wages. (Zealand Statistics, 2008).

After cross-referencing, the weights are calculated by putting the wage shares of each category in the Törnqvist formula and creating an index number for each period.

$$(\ln T_t = \frac{1}{2} \sum (v_{it-1} + v_{it}) \times \ln \frac{H_{it}}{H_{it-1}}) \quad (2)$$

Where v_{it} and v_{it-1} represent the weight of labor in the i -th category in the current and previous years, and H_{it} a H_{it-1} represent hours worked in the i -th category, also in the current and previous years. T represents the movement in the compositional work, which is the sum of the weighted movements for each category.

As the above equation shows, two periodic weights are used in this analysis. Weights for individual years are calculated as:

$$(v_{it-1} = \frac{W_{it-1}H_{it-1}}{\sum_j W_{jt-1}H_{jt-1}}) \quad (8)$$

$$(v_{it} = \frac{W_{it}H_{it}}{\sum_j W_{jt}H_{jt}}) \quad (9)$$

Where W_{it} and W_{it-1} present the hourly wage of work in category i . The current methodology replaces wages in the given period with imputed wages. Thus, instead of a simple sum of hourly growth rates, it is a weighted sum, where weights are average shares of labor costs (Zoghi, 2010). The growth of the composition of labor is the difference between this growth of the input of labor by the adjusted composition and the unadjusted growth of the input, which is measured as:

$$(\Delta H = \ln \frac{H_{it}}{H_{it-1}}) \quad (10)$$

Where H_{it} and H_{it-1} represent hours worked in the i -th category in the current and previous year.

Since official productivity statistics are a relatively new phenomenon in many countries, data series are generated depending on what relevant and how many appropriate data sets have been compiled before, leading to differences in methodologies between countries. The OECD describes adjusting the composition as "desirable but complex", highlighting its potential benefits, but recalls that explicit differentiation is both data-intensive and research-intensive. Although only a simple trait, such as a profession, is chosen to differentiate the workforce, the information requirements are high: data are needed that break down the total hours worked in different occupations by sector and by year. In addition, in order to construct weights for aggregation, quantitative labor input rates (hours) must be accompanied by relative average compensation price measures (Zealand Statistics, 2008).

4 Conclusion

The post-crisis period brought the Slovak economy several changes in the dynamics not only of economic growth, but also in the contribution of its factors to growth. As a result of the decline in employment, the impact of the labor factor on the dynamics of gross domestic product decreased and the pro-growth effect of capital increased. This approach takes employment into account as such, does not take full account of its qualitative aspects, which are, in particular, the level of education, skills and abilities of workers. This option is brought about by an approach which, in addition to the number of hours worked, also emphasizes a change in the quality of the workforce in changes in employment.

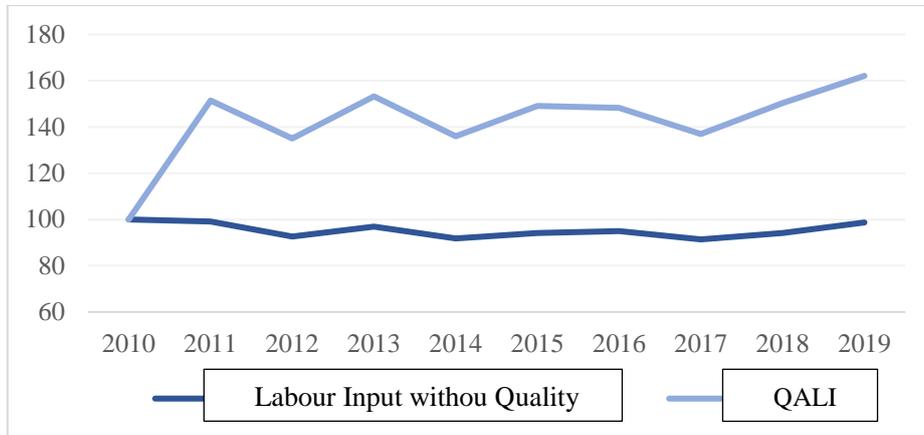


Fig. 4. Development of labor productivity (b. p. in %, year 2010 = 100%)

If we look at a well-adjusted input of labor (Fig. 1), we see that its contribution to the development of productivity increased in the period under review. The gradual growth of employment in the post-crisis period caused a more dampening effect on the growth of labor productivity, a positive tendency, albeit with fluctuations in time, seen in the qualitatively adjusted input of labor.

	QALI (11)	QALI (12)	QALI (13)	QALI (21)	QALI (22)	QALI (23)	QALI (31)	QALI (32)	QALI (33)	QALI for industry
Agriculture, veterinary and fisheries	- 0,15	- 0,01	- 0,43	- 0,35	- 0,34	- 0,03	- 0,56	- 0,01	- 0,14	- 0,82
Mining and processing of raw materials, geology	- 0,43	- 0,40	- 0,52	- 0,21	- 0,51	- 0,02	- 0,31	- 0,05	- 0,13	- 1,37
Food industry	- 0,16	- 0,57	- 0,23	- 0,32	- 0,29	- 0,04	- 0,34	- 0,11	- 0,20	- 1,24
Textiles, clothing, footwear and leather processing	- 0,43	- 0,71	- 0,15	- 0,36	- 0,46	- 0,29	- 0,65	- 0,03	- 0,11	- 1,53
Forestry and wood processing industry	- 0,47	- 0,43	- 0,26	- 0,03	- 0,17	- 0,17	- 0,33	- 0,15	- 0,48	- 0,12
Pulp and paper printing industry	- 1,27	- 0,47	- 0,23	- 0,19	- 0,32	- 0,12	- 0,41	- 0,08	- 0,36	- 0,20
Chemistry and pharmacy	- 0,33	- 0,12	- 0,03	- 0,21	- 0,04	- 0,21	- 0,52	- 0,23	- 0,16	- 0,07
Metallurgy, foundry, blacksmithing	- 0,30	- 0,05	- 0,08	- 0,27	- 0,16	- 0,04	- 0,50	- 0,23	- 0,56	- 0,15
Glass, ceramics, mineral products, non-metallic materials	- 0,27	- 0,33	- 0,32	- 0,03	- 0,37	- 0,23	- 0,65	- 0,11	- 0,16	- 1,55
Automotive industry and engineering	- 0,86	- 0,02	- 0,14	- 0,58	- 0,17	- 0,60	- 0,22	- 0,36	- 0,33	- 2,79
Electrical Engineering	- 0,27	- 0,58	- 0,34	- 0,42	- 0,09	- 0,53	- 0,33	- 0,36	- 0,46	- 0,66
Energy, gas, electricity	- 0,33	- 0,11	- 0,19	- 1,16	- 0,47	- 0,04	- 0,59	- 0,02	- 0,08	- 2,74
Water, waste and the environment	- 0,20	- 0,12	- 0,01	- 0,04	- 0,24	- 0,39	- 0,03	- 0,21	- 0,40	- 0,79
Construction, geodesy and cartography	- 0,07	- 0,48	- 0,23	- 0,06	- 0,27	- 0,07	- 0,23	- 0,03	- 0,17	- 0,99
Business, marketing, gastronomy and tourism	- 0,15	- 0,44	- 0,00	- 0,15	- 0,13	- 0,12	- 0,24	- 0,26	- 0,32	- 0,11
Transport, logistics, postal services	- 0,22	- 0,23	- 0,07	- 0,37	- 0,15	- 0,37	- 0,47	- 0,19	- 0,44	- 0,09
Information technology and telecommunications	- 1,16	- 0,35	- 0,18	- 0,10	- 0,13	- 0,50	- 0,25	- 0,29	- 0,74	- 2,65
Banking, financial services, insurance	- 0,00	- 0,47	- 0,21	- 0,34	- 0,30	- 0,17	- 0,39	- 0,25	- 0,38	- 0,91
Culture and publishing	- 0,01	- 0,58	- 0,10	- 0,88	- 0,42	- 0,30	- 0,47	- 0,00	- 0,13	- 2,00
Education, training and sport	- 0,92	- 0,27	- 0,15	- 0,25	- 0,15	- 0,29	- 0,17	- 0,28	- 0,26	- 0,77
Public services and administration	- 1,25	- 0,45	- 0,03	- 0,48	- 0,25	- 0,22	- 0,06	- 0,22	- 0,29	- 1,78
Administration, economics, management	- 0,88	- 0,02	- 0,19	- 0,90	- 0,52	- 0,76	- 1,41	- 0,69	- 0,41	- 5,40
Healthcare, social services	- 0,45	- 0,19	- 0,38	- 0,49	- 0,24	- 0,46	- 0,36	- 0,22	- 0,55	- 0,13
Crafts and personal services	- 0,52	- 0,02	- 0,66	- 0,32	- 0,00	- 0,37	- 0,11	- 0,28	- 0,42	- 2,66

Tab. 5. Development of qualitative input of work and its segments (year 2009 = 100%, in%)

The positive development of the qualitative input of work in the whole monitored period was most significantly influenced by the branches of administration, economy and management (Table 1). Qualitative factors have also increased positively in the automotive, information and communication technology, and public services and administration sectors.

Examining the development of the QALI indicator for individual groups in all 24 sectors of the Slovak economy, we found that the QALI indicator in all sectors fluctuated significantly in the period under review, between 2010-2019 and thus in none of the sectors there was continuous growth or decline periods of growth alternated between periods of decline and decline in growth.

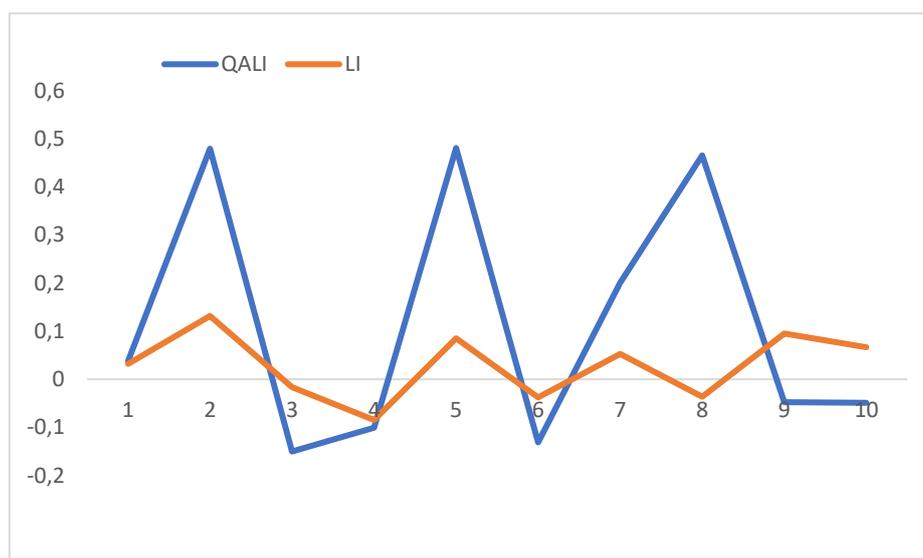


Fig. 2. Comparison of the development of the labor contribution considering the quality factor (QALI) and the labor contribution without considering the quality factor (LI) in the observed period

Comparing 2009 and 2019, we evaluated in which sectors the qualitative aspect of work grew the most and identified five main sectors, which are administration, economics and management, automotive and engineering, craft and personal services, information technology and telecommunications, and public services and administration. On the other side of the spectrum, the most significant decline was recorded in sectors such as energy, gas and electricity, culture and publishing or glass, ceramics, mineral products, non-metallic materials.

We use wages when calculating the QALI indicator as a weight of average shares of costs for a specific category of employees from the average hourly wage for a given category, which we use to weight changes in time worked. The wage variable plays an important role here, as it ensures the qualitative aspect of this indicator. Wages are not the same among heterogeneous types of workers. According to the theory, these wages

should reflect differences in marginal productivity of workers, and on the basis of this assumption, the types of workers are divided into groups according to certain predetermined characteristics with different corresponding wages. Thus, the wage in the formula represents the factor of qualification, education or age.

We use the regression model primarily as a supplement, which serves to support the QALI indicator. Since the weights entering its calculation are just hourly wages, the regression model should underline their validity and importance in the calculation. It is generally accepted that age, and especially education, has a positive effect on wage developments over an individual's life. As we have mentioned many times in our work, taking a closer look at the development of wages between 2009 and 2019 in individual sectors, we could see significant differences in average hourly wages between individual educational and age groups. Our regression model also confirms this.

The regression model in our work is a Mincer type model, consisting of panel data with 2376 observations. We used the log-lin model for simple data interpretation. In Picture 1: Regression model for 24 branches of the Slovak Republic, we can see that all variables entering the model are statistically significant at the 95% confidence interval and have a positive effect. Based on the model, we can state that age, but especially the level of qualification (education) have a significant positive effect on the change in the average hourly wage.

Model 1: Pooled OLS, using 2376 observations					
Included 216 cross-sectional units					
Time-series length = 11					
Dependent variable: l_avg_e_i					
	coefficient	std. error	t-ratio	p-value	
const	0,889341	0,0214228	41,51	1,20e-283	***
ED	0,365481	0,00727695	50,22	0,0000	***
age	0,105140	0,00727695	14,45	2,05e-45	***
Mean dependent var	1,830583	S.D. dependent var	0,424582		
Sum squared resid	199,0452	S.E. of regression	0,289619		
R-squared	0,535093	Adjusted R-squared	0,534701		
F(2, 2373)	1365,625	P-value(F)	0,000000		
Log-likelihood	-425,5838	Akaike criterion	857,1676		
Schwarz criterion	874,4871	Hannan-Quinn	863,4716		
rho	0,969927	Durbin-Watson	0,078537		

Pic. 1. Regression model for 24 industries of the Slovak Republic

A closer look at the structure of the components contributing to the growth of values found that the development in individual sectors was different and the growth in the sectors was of a different nature. In some sectors it came from an increase in the contribution of the skilled workforce, in others it was caused by an increase in the number of hours worked by the lower skilled workforce.

5 Discussion

There are also methodological shortcomings of the QALI indicator. The calculation, which uses wages as weights of average shares of costs for a particular category of workers from the average hourly wage for a given category, by which we weight changes in hours worked, is largely dependent on the development of the number of hours worked. Especially in sectors where wages do not sufficiently reflect the qualifications of the workforce, this workforce is underestimated, such as in the education sector. In this case, the wage, which in the calculation represents the qualitative aspect of the labor force, is not the most suitable variable for weighting the change in hours worked, but a conceptually better indicator has not yet been devised to represent a quality factor that would sufficiently capture and quantify it to such an extent as wages. As our regression model also pointed out, age, but especially the level of qualification (education) have a significant positive effect on the change in the average hourly wage.

However, it is clear from our results that the qualitative aspect contributes to a greater extent to the growth of the values of the contribution of labor and to the reduction of the falls in its values. Considering the qualitative aspect brings the possibility to better assess the structure of the growth of the contribution of labor, allows its easier decomposition and points to the difference in values, compared to the contribution of labor without considering the quality factor that would not otherwise be considered.

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Impact of Public Debt on Long-Term Interest Rates

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Abstract: In this paper, I have tried to answer whether higher public debt in advanced economies leads to rising long-term interest rates. First, I estimated the impact of public debt on long-term nominal interest rates on a sample of 18 advanced economies in the years 1950-2017 using a fixed effects model in various specifications. The effect of debt remained insignificant in all specifications. Second, with the help of a novel way of visualizing rolling-window regression inspired by [12], I have shown that the impact of public debt is in fact time-varying, and a positive significant effect is rather a hallmark of recent decades.

Keywords: Long-term interest rates, Public debt, Panel estimation, Rolling-window regression

JEL classification: H63, E43

1 Introduction

Does high public debt lead to higher long-term interest rates? Many authors have found a positive relationship between these variables (e.g., [2], [10], [13]). The reason why this relationship should hold may be, for example, due to the well-known crowding-out effect, or owing to the increase in the risk premium, which is the investor's response to a higher probability of default. In the current situation where public debts of advanced economies are growing at a rapid pace because of a pandemic, I consider my research question to be highly relevant.

The main objective of this paper is to examine the relationship between public debt and long-term interest rates in 18 advanced economies. I estimate the effect of public debt on long-term nominal interest rates on a whole sample of countries in the years 1950-2017 using a fixed effects model in various specifications. The impact of debt has remained insignificant in all specifications. I have also found that Euro area countries have long-term interest rates lower by more than 2 percentage points in average, but surprisingly, the impact of public debt on interest in these countries is positive - a 10

percentage point increase in debt is associated with an increase in interest rates of around 20 basis points.

Since several studies conducted on shorter time spans have found a relatively robust positive effect of public debt, I have hypothesized that the effect of public debt may be time-varying over a long period of time, which may affect estimates on long-term samples. Although the time varying effects of public debt have been studied by several authors (e.g, [3], [4]), they have used relatively short periods and arbitrarily chosen lengths of time windows. In this paper, I address these shortcomings and estimate 1922x2 regressions (for nominal and real interest rates respectively), which cover all periods between 1950-2017 and all possible time windows with a minimum length of 5 years. With the help of a novel way of visualizing rolling-window regression inspired by [12], I have shown that the impact of public debt on interest rates is in fact time-varying over a long period of time and a positive significant effect is rather a hallmark of recent decades.

2 Literature Review

There are mostly two main theoretical reasons why higher public debt and government deficits should lead to higher interest rates. The first argument comes down to the so-called crowding-out effect, which is based on the reasoning that expansionary fiscal policy displaces private investment and results in a lower equilibrium capital stock, which is associated with a higher marginal product of capital, and thus higher real interest rates [2], [5]. The second reason is the channel of uncertainty, where higher public debt may increase the default risk, which may lead to a higher risk premium and higher bond yields [6], [10].

[2] find a significant impact of fiscal variables on long-term nominal interest rates in a panel of 16 OECD countries between 1960 and 2002. The effect of the primary government balance is negative and linear, while effect of public debt is non-linear. If a country has a public debt of 119% of GDP (such as Italy in 2002), an increase in debt of one standard deviation leads to an increase in nominal yields on 10-year government bonds of 86 basis points¹. Nevertheless, the same shock to government debt in a country with a 58% public debt-to-GDP ratio (such as the USA in 2002) leads to an increase in nominal interest rates of only 10 basis points. Among other things, [2] observe that an increase in total government debt in OECD countries leads to an increase in bond yields, suggesting some interconnection between advanced economies.

[6] addresses the impact of fiscal policy on interest rates in the context of the European Monetary Union (EMU). The main objective of his paper is to test whether expansionary fiscal policy in one country affects interest rates in that country alone, or if spatial effects are present. [6] confirms both hypotheses with the estimated effect being higher for the latter, suggesting strong spillovers through an interest rate channel among fiscal policies of the EMU countries. In economies with high public debt, the dynamics as well as the stock of public debt have a stronger impact on domestic interest

¹ [2] point out that in their sample, one standard deviation of public debt to GDP is equal to 26 percent, which is a rather significant change.

rates. According to [6], his findings on significant spillovers between EMU countries are an argument in favor of rigorous enforcement of the rules of the Stability and Growth Pact.

[10] examine the impact of public debt on interest rates in both linear and non-linear model specifications based on panel estimates in 31 advanced and emerging economies during the period 1980-2008. They suggest that a 20-percentage point increase in public debt to GDP increases total interest expenditure as a share of GDP by 0.8 percentage points in G-20 economies and by about 1.7 percentage points in advanced G-20 economies. The authors also regard the initial fiscal position, institutional and other structural conditions, and spillovers from global financial markets as important determinants in the relationship between fiscal variables and interest rates.

Endogeneity is a major problem in estimating the impact of fiscal variables on interest rates. Let us suppose the economy is in a recession. Automatic stabilizers respond to the phase of the business cycle, increasing government deficits and debt. At the same time, however, expansionary monetary policy is pushing rates down in response to the recession. For this reason, fiscal deficits may be negatively correlated with long-term interest rates, which contrasts with the standard economic theory [11]. [11] deals with the problem of endogeneity by using projected values instead of actual values of the variables. He conducts his analysis on data for the United States, using 5-year debt and deficit projections from the Congressional Budget Office (CBO) as explanatory variables, and 5-year forward rates on 10-year government bonds as a dependent variable. By means of this approach, he gets rid of other influences on variables and largely eliminates the problem of endogeneity. [11] finds that an increase in the projected deficit to GDP of 1 percentage point is associated with an increase in the forward rate by 22 basis points. An increase in the projected public debt to GDP by a percentage point results in an increase in the forward rate by 3-4 basis points. A significantly lower impact of public debt on forward interest rates is discovered from the panel data analysis by [7]. Based on their estimates, 1 p. p. increase in gross government debt-to-GDP ratio raises forward long-term interest rates by 2.5 basis point when the increase in debt is financed entirely from abroad, and only 0.8 basis point with domestically financed new debt. They conduct this study on a sample of 10 advanced economies during the 1990-2010 period [7].

According to [13], when analyzing the determinants of long-term interest rates, it is important to distinguish between short-term and long-term effects. In recent decades, there has been a long-term declining trend in interest rates in advanced economies. For this reason, it is appropriate to draw a distinction between factors affecting the long-term trend and those that explain short-term fluctuations. Following this logic, [13] uses cointegration methods which can address these problems. He analyzes annual observations on a sample of 22 developed economies during the years 1980-2010. The main finding is that in the long run, an increase in public debt to GDP of 1 percentage point increases long-term interest rates by about 2 basis points. In the short run, the change in public debt to GDP, the change in the money market rate and the change in inflation have a substantial effect on the change in long-term interest rates.

[8] examine the relationship between government debt and real GDP growth through the real interest rate channel. The growth of public debt to GDP may lead to increased

doubts about the ability to repay accumulated debt, which increases the risk premium, and thus real interest rates. An increase in real interest rates can, therefore, translate into a reduction in interest-sensitive expenditures, thereby slowing down economic growth. To examine this hypothesis, they employ a panel VAR model with 31 countries of the European Union and the OECD between 1995 and 2013. [8] do not find the presence of Granger causality in the direction from public debt to interest and real growth. However, they discover reverse causality in the direction from growth to debt, where the interest rate acts as a transmission channel.

This paper may contribute to the current state of knowledge in two ways. Firstly, by examining the effect of public debt on nominal long-term interest rates over a long time span (1950-2017). Secondly, by properly addressing potential time-varying effect of public debt.

3 Methodology and data

In the analysis I use a database from [9], which contains data on macroeconomic and financial indicators for 18 advanced economies in the period 1870 to 2017. Given the goal of this paper, I have decided not to use the whole sample for two reasons: the quality of the available data for the observed variables is lower for older data, and it is not possible to draw conclusions from the late 19th century data, which could have a bearing on contemporary economic policy decisions. Based on this consideration, a sample of the post-war period (1950-2017) is used. I use data for the following countries: Australia, Canada, Finland, Germany, Japan, Norway, Spain, Switzerland, USA, Belgium, Denmark, France, Italy, Netherlands, Portugal, Sweden, UK, Ireland.

The dependent variable in the analysis is the nominal long-term interest rate proxied by 10-year government bond yields. The primary source is the International Financial Statistics (IFS) database from the IMF. To control for the effects of monetary policy the short-term nominal interest rates are used which are captured using money market rates, the source of which is also the IFS database. The inflation rate is calculated as a year-to-year percentage change in the consumer price index, the primary source of which are statistical offices of individual countries. To capture the fiscal position, I used the primary balance to avoid the problem of reverse causality, as the total fiscal balance also includes interest payments. The public debt to GDP variable shows gross general government debt as a share of nominal GDP. Fiscal variables are obtained from various primary sources, which are described in detail in the database documentation by [9]. Cyclical position is captured by real GDP growth, which is calculated as the year-to-year percentage change in nominal GDP and deflated by the CPI. Real long-term interest rates are calculated as the difference between nominal interest rates and CPI inflation. The dummy variable Euro area takes on the value 1 since the country entered the Euro area. The period after the financial crisis is captured by the dummy variable, which has value of 1 since 2008 in all countries. None of the variables are differentiated, as stationarity is not a necessary condition for using a fixed effects estimator. All control variables are based on relevant empirical literature (eg, [2], [10], [13]). Table 1 shows summary statistics and Figure 1 shows the evolution of the average long-term

interest rate and the average public debt to GDP. From this picture you can see long-term trends and several structural breaks, which justifies controlling for time-specific effect in panel regression.

Table 5: Summary statistics. Source: own calculations based on data from [9]

Variable	Unit	Obs.	Mean	St. Dev.	Min	Max
Long-term interest rate	Nominal, %	1,224	6.58	3.69	-0.36	21.50
Long-term interest rate	Real, %	1,224	2.17	3.67	-30.38	19.09
Short-term interest rate	Nominal, %	1,216	5.46	4.15	-2.00	21.27
Public debt	% of GDP	1,215	52.97	34.93	4.26	236.71
Primary public balance	% of GDP	1,220	-1.57	3.96	-15.92	20.08
CPI inflation	%	1,224	4.41	4.56	-6.87	37.88
GDP growth	Real, %	1,224	3.53	3.84	-12.81	35.31
Euro area	Dummy	1,224	0.16	0.36	0.00	1.00
Post 2008 crisis	Dummy	1,224	0.15	0.35	0.00	1.00

To estimate the impact of public debt on long-term interest rates, I use a fixed effects estimator with robust standard errors to autocorrelation and heteroscedasticity. The fixed effect model controls for an unobserved cross-sectional effect that is correlated with explanatory variables and is constant over time. The application of the fixed effects estimator is also supported by the Hausman test.

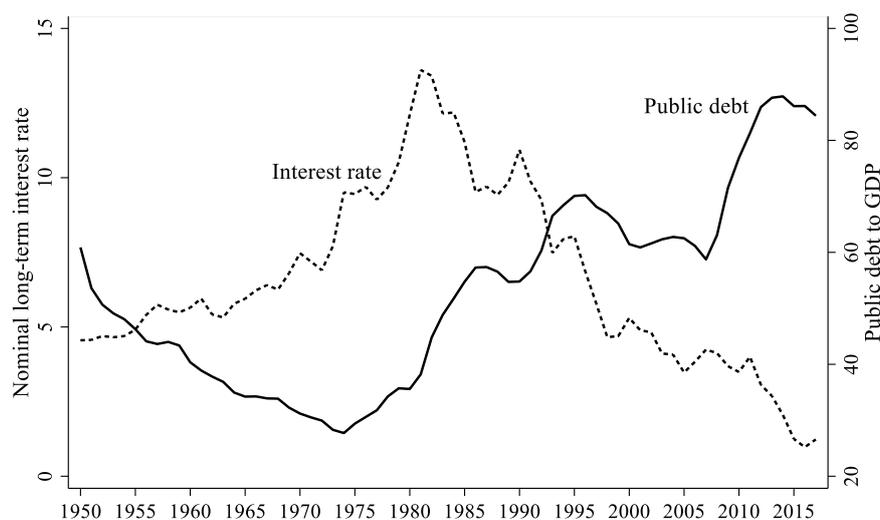


Figure 6: Evolution of average long-term interest rates and public debt to GDP in advanced economies. Source: own calculations based on data from [9]

4 Results

The panel data analysis is frequently employed in the estimation of the relationship between public debt and long-term interest rates (e.g., [2], [10], [13]), but these studies

cover a maximum period of 30 years and do not include period after the financial crisis. To the best of my knowledge, the potential time-varying effect of public debt on long-term interests was addressed only by [3] and [4]. This paper will contribute to the literature in two ways: i.) by examining the long period of time since 1950 in advanced economies; ii.) by estimating the impact of public debt using rolling-window regression without an arbitrarily chosen length of time window.

4.1 Main estimation

I estimated the impact of public debt on interest rates using a fixed effects model, which was applied to panel data from 18 advanced economies in the period 1950-2017. The dependent variable is long-term nominal interest rate proxied by 10-year government bond yields and the base specification uses common control variables capturing economic development. The results of the panel regression estimates are shown in Table 2. The models (1) and (2), where the basic control variables are used, the impact of public debt is statistically insignificant and the direction of the effect of the control variables is in line with theoretical expectations. The models (3) and (4), I at least partially addressed the endogeneity problem using two-stage least squares regression. Lagged values of the public debt to GDP were used as an instrument, but the impact remained insignificant in this case as well. I was also unable to demonstrate the non-linear effect of public debt on nominal interest rates (columns (5) and (6)), which several authors found in OECD countries [2] or in a mixed sample of emerging and advanced economies as well [10]. According to my estimates, membership in European Monetary Union (EMU) reduces nominal 10-year government bond yields by about 2 percentage points in average, which may be associated with lower exchange rate risk and a significant decline in the risk perception of countries from the financial markets, which is also supported by [3]. This effect remains significant even though I am controlling for the period after financial crisis, when the policy-rate hits the zero low bound. The impact of public debt on long-term interests is statistically significant in the Euro area countries and results in rising interest rates (10 p. p. increase in public debt leads to higher interest rates by about 20-25 basis points), which contradicts the findings of [13], who found the negative impact of public debt on real long-term interest rates in EMU. The debt crisis in the Eurozone, where interest rates have risen significantly in several countries due to problematic sovereign debt financing, is a possible explanation (however, only Ireland and Portugal are significantly affected countries in the dataset used).

Table 6: Panel regression estimates, 18 advanced economies, 1950-2017. Source: own calculations based on data from [9]

Dep.: Nominal long-term interest rate	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	FE	FE	2SLS	2SLS	FE	FE	FE	FE	FE
Short-term	0.7116 ^a	0.5875 ^a	0.7099 ^a	0.5858 ^a	0.7112 ^a	0.5900 ^a	0.6940 ^a	0.5745 ^a	0.6676 ^a

interest rate	(0.028)	(0.038)	(0.028)	(0.038)	(0.028)	(0.038)	(0.034)	(0.034)	(0.040)
		0.0663 ^c		0.0614 ^c		0.0663 ^c			
CPI inflation	0.0707 ^c		0.0667 ^c		0.0730 ^c		0.0656 ^c	0.0731 ^c	0.0681 ^c
	(0.034)	(0.035)	(0.035)	(0.037)	(0.034)	(0.035)	(0.035)	(0.037)	(0.03)
Real growth	0.0004	0.0040	-0.0013	0.0027	0.0016	0.0044	-0.0121	0.0036	-0.0236
	(0.017)	(0.014)	(0.016)	(0.014)	(0.015)	(0.013)	(0.014)	(0.014)	(0.014)
	-	-	-	-	-	-	-	-	-
Primary balance	0.1372 ^b	0.0945	0.1447 ^b	0.1005	0.1356 ^b	0.0926	0.1320 ^b	-0.0987	0.1415 ^b
	(0.060)	(0.687)	(0.061)	(0.070)	(0.061)	(0.069)	(0.058)	(0.069)	(0.060)
Public debt to GDP	-0.0017	0.0022	-0.0030	0.0014	0.0016	0.0068	-0.0030	-0.0006	-0.0021
	(0.004)	(0.003)	(0.004)	(0.003)	(0.012)	(0.012)	(0.003)	(0.003)	(0.003)
Public debt to GDP squared					-0.0000	0.0000			
					(0.000)	(0.000)			
Euro area dummy							2.1071 ^a	2.0896 ^b	2.2023 ^a
							(0.566)	(0.772)	(0.563)
Euro area * Public Debt/GDP							0.0211 ^a	0.0250 ^b	0.0258 ^a
							(0.007)	(0.009)	(0.007)
Post crisis dummy (2008-2017)									0.8001 ^a
									(0.227)
Constant	2.2638 ^a	2.494 ^a	2.3536 ^a	2.000 ^a	2.1521 ^a	2.354 ^a	2.5936 ^a	2.7012 ^a	2.7859 ^a
	(0.317)	(0.473)	(0.312)	(0.580)	(0.496)	(0.609)	(0.359)	(0.448)	(0.369)
Time dummies	No	Yes	No	Yes	No	Yes	No	Yes	No
Observations	1,206	1,206	1,187	1,187	1,206	1,206	1,206	1,206	1,206
R-squared	0.8305	0.8604	-	-	0.8306	0.8605	0.8366	0.8649	0.8404
Countries	18	18	18	18	18	18	18	18	18

Robust standard errors in parentheses

a: $p < 0.01$, b: $p < 0.05$, c:

$p < 0.1$

4.2 Time varying effect of public debt

The results of the panel regression in advanced economies on the whole sample of data did not confirm a significant positive impact of public debt on nominal long-term interest rates. However, this finding is not in line with the majority literature (e.g., [2], [10], [13]). These studies used very similar model specifications, but differed in the sample of countries, time period ([10] - 31 developed and emerging economies in the period 1980-2008, [13] - 22 developed countries in the years 1980-2010, [2] - OECD countries in the two periods 1960-2002 and 1975-2002) and [13] also in the estimation technique (PMG estimator). Given that, I have estimated the relationship between public debt and nominal interest rates over the longest time span in the relevant literature, but the estimates may be biased if the relationship between the variables has changed significantly over time.

I estimate the impact of public debt on the long-term nominal interest rate in the base specification (column (2) in Table 2) with time dummies and using a fixed effects

estimator. Unlike standard rolling-window regression, where the author chooses the length of the period arbitrarily, in this case I estimate the model for all possible periods between 1950 and 2017, with a minimum time span of 5 years. For one specification, I therefore estimated 1922 regressions. The resulting estimates of the beta coefficients for public debt can be seen in Figure 2 on the left, with each circle showing an estimate of the effect of public debt in the period, the beginning of which is on the y-axis and the end on the x-axis. For example, the circle at the bottom right shows the estimated impact of debt on the whole sample between 1950 and 2017. Figure 2 on the right shows the statistical significance of the coefficients, with the white circles showing a non-significant effect (as with the estimates in previous section, robust standard errors were used).

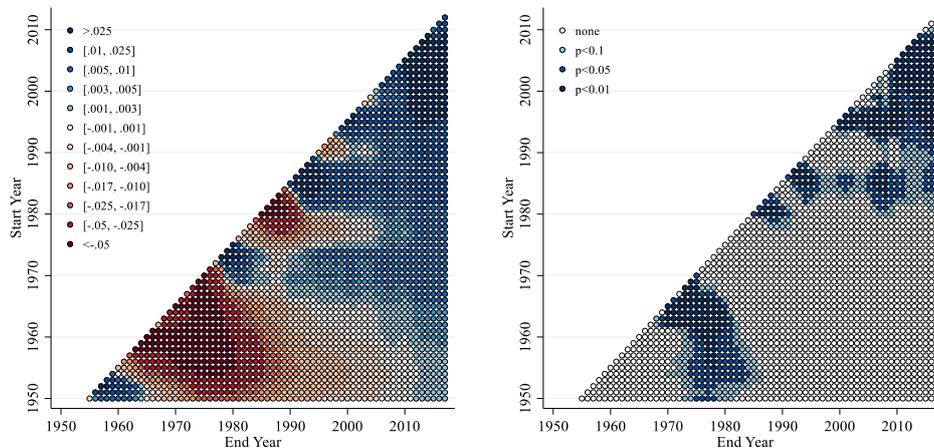


Figure 7: Rolling-window estimates, Dep.: nominal long term interest rates. Source: own calculations based on data from [9], visualization inspired by [12]

In most time periods, the estimated effect of public debt on nominal long-term interest rates is insignificant. During the periods ending in the 1970s and 1980s, when nominal interest rates were highest due to persistently high inflation, the estimated impact of debt is even negative, but not robust as shown in specification with real interest rates (Figure 3). Including later periods, the estimated effect is statistically insignificant, which changes from 1990 to the present, when the impact of public debt is positive. However, this reversal in the debt effect may be driven by the Euro area, in which the positive impact of debt has been confirmed in the previous section. One of the explanations may be the debt crisis, but this would not explain the estimates in the pre-crisis period, which are also mostly significant. If these estimates are driven by the Eurozone, then another possible justification may relate to the handing over of monetary policy conduct to the ECB. The Maastricht Treaty also enshrined the so-called no-bail out clause, which prevented other Euro area members from taking over debts. Together, these factors may have created the preconditions in which excessively high debts could lead to a higher risk of default compared to countries with sovereign monetary policy.

To verify the results of the rolling-window regression in Figure 2, in the next step I estimated the impact of public debt on real long-term interest rates. The control variables used, and the estimation method remain the same, except that in this case the inflation rate already contained in the dependent variable has been removed from the specification. Figure 3 shows that the estimates in this specification are consistent with previous findings. In this case, however, the impact of public debt on real interest rates is already significant in the periods beginning in the 1980s. The above findings confirm the hypothesis of the time-varying effect of public debt on long-term interest rates and show that the choice of period as well as the length of the time window is important in the analysis of this relationship. Estimates from recent decades suggest that public debt increases interest rates, but the robustness of this claim should be addressed in future research, for example, by better endogeneity addressing.

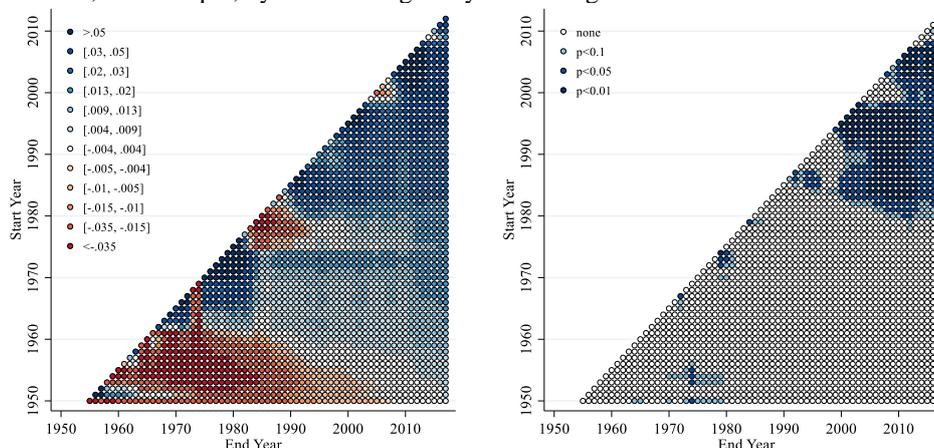


Figure 8: Rolling-window estimates, Dep.: real long term interest rates. Source: own calculations based on data from [9], visualization inspired by [12]

Conclusion

In this paper, I have tried to answer whether higher public debt in advanced economies leads to rising long-term interest rates. I estimated the impact of public debt on long-term nominal interest rates on a sample of 18 advanced economies in the years 1950-2017 using a fixed effects model in various specifications. The effect of debt remained insignificant in all specifications. I have also found that Eurozone countries have long-term interest rates lower by more than 2 percentage points, but surprisingly, the impact of public debt on interest rates in these countries is positive - a 10 percentage point increase in debt is associated with an increase in interest rates of around 20 basis points. Since the finding of an insignificant impact of public debt is contradictory with the majority literature, it is possible that estimates over such a long-time horizon may be biased by a change in impact over time. Then, I estimated rolling-window regression on all possible periods between 1950-2017 and the impact of public debt on nominal long-term interest rates has proved insignificant in most models. According to these

findings, the significant and positive effect of debt is only characteristic of recent decades. These conclusions were also supported by estimating rolling-window regression with real interest rates as a dependent variable and it will be the task of further research to find out why².

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² Data and code in Stata:

https://www.dropbox.com/s/13ar9mfmfy41nwh/impact_of_public_Debt_on_long-term_interest_rates.rar?dl=0

Determining the product price of duopolist considering his limited offer and different demands of nodes

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Abstract. Game theory, and its specific area – spatial games, deal with the behavior of competitors. Spatial games focus on analyzing imperfect competition from a spatial point of view and the competitors represent companies operating in the market with the aim to attract customers and find the best location for their branch. Each company applies its own pricing policy, which affects its market share. In this article we present formulation and solution of a specific spatial game of two players who decide on the locations of their branches in space and want to maximize their revenues. The space is characterized by a graph, where location of customers and possible places of service represent its nodes. Customers choose one of the companies based on their total costs, consisting of the price of the product and shipping costs. The service in each of the nodes must be performed by either one or the other player. Such a situation can be analyzed using zero-sum games. The article presents the issue of determining the price of one player, based on a predetermined price of the opponent, to have player's revenues as high as possible. The game considers limited offer of the first player and different demands in each of the nodes.

Keywords: Spatial competition, Pricing, Matrix games, Imperfect competition, duopoly

JEL classification: C 70, C 72, D 43

1 Introduction

To operate in the market and maintain or improve its position, company must be competitive, which is closely linked to the prices of its products and services and their quality. To secure its position and market share, the company must proceed

strategically. The concept of strategy can be found in various fields, one of which is game theory. It is a tool for analysing the strategic behaviour of players who can represent any entity in a conflict decision-making situation. In the market, it is precisely companies that find themselves in a conflict situation with competing companies offering the same or similar products and services. Each of these companies aims to gain as many customers as possible, increase their market share and maximize their profits. The path to success is defined at the outset by several factors. One of them is the choice of location, whether it is warehouses, branches, operations, production facilities, or equipment. Location models address this issue, while the problem of location can be defined at the level of municipalities, cities, regions, or states.

How a company behaves in the market is also influenced by the type of structure of the market in which it operates. In the market, we generally distinguish between perfect and imperfect competition, both of which are characterized by their specific features. Imperfect competition is characterized mainly by the ability to set and control product prices by companies or manufacturers (Samuelson and Nordhaus 2010).

The behaviour of the firms in the market of imperfect competition must consider the decisions of other subjects (whether on the supply or demand side). That means, when deciding on the quantity and price of the offered product, the company must, as part of an oligopolistic market structure, consider the steps of other companies. Such strategic interactions and their market specifications can be explained using game theory (Varian 1992). From the point of view of the game theory, the decision-making situation of individual oligopolists can then be considered as a game in which players try to maximize their expected payment by their strategic behaviour.

In the article we present the duopolistic market, defined by two companies operating in the market, in a space that can be characterized by a graph. Players make their decisions about the location of the operation simultaneously. It is a one-round game, the results of which are determined by setting the prices of their products, which also affect their respective market share (and thus sales). We will design an original mathematical model, based on which it is possible to set the price for one player based on the price of his opponent, which is known in advance, so that his sales are as high as possible. We consider additional condition of a limited supply and various demands in each possible location, which also represents location of customers choosing one of the duopolists based on their lower costs, which include both the price of the goods and transport costs.

2 Models of spatial competition

The basis of an open market economy is free competition, which is a conflict of interest. The analysis of the oligopolistic market in space is currently increasingly discussed topic. One of the first to address this issue was the mathematician and economist H. Hotelling (1929), who presented a model based on the presence of two companies looking for the most advantageous position in the linear market. The model is the basis of many theories of product differentiation and location, but despite its applicability, it has undergone many criticisms. For example, C. D'Aspremont, J. Jaskold Gabszewicz

and J.-F. Thisse (1979) points out its flaw and proves that it is not possible to have a balance if companies are close to each other. The result of their modified model is a model whose solution ensures the existence of equilibrium at any point in the market (D'Aspremont et al. 1979).

Even though the beginnings of the issue of spatial models are associated with Hotelling, in fact, the first known attempt to analyse economic activity in space is associated with the Thünen (1826), whose theory explained the location of production activities in an isolated city-state with land and homogeneous resources (Gehling, 1968). Weber (1909) later developed a theory of the location of industry.

Also, before Hotelling, in 1924, Fetter, one of the first authors to lay the foundations for the analysis of relationships and interdependencies between firms, published his work with a significant impact on network competition theory. Unlike Hotelling, Fetter focused on modelling demand behavior, not on optimal decisions (Biscaia and Mota, 2013). A further extension of Fetter's work can be found in the publications of many other authors, such as (Hamoudi and Martín-Bustamante, 2011) and (Hamoudi.a Risueño, 2012).

Other publications are proof that Hotelling's model has laid the foundations for several other works dealing with this issue. (Beath and Katsoulacos, 1991) is also based on his model. The authors deal, among other things, with the price competition of the spatial duopoly. Customers located along the linear market, forced to travel if they want to buy the products on offer, are the only ones who bear the transport costs. The location is an exogenous parameter for the companies, so price is their only decision variable (Beath & Katsoulacos, 1991).

3 Determining the product price of duopolist based on best response

In this section, we will present an original mathematical model that allows us to determine the price of the product of duopolist based on the determined price of the opponent in the case of a specific spatial game with the assumption of limited capacity of the duopolist determining price of his product and different demand in each possible location. The idea of the paper will be based on (Čičková and Holzerová, 2020). The paper was focused on modelling the pricing of the product price of duopolist based on best response model in case where each of the customers always made a purchase from the player, where the total costs associated with the purchase were lower. The specific model was based on zero-sum game model.

In the model, like Hotelling in his basic model, we apply the basic assumptions: product homogeneity (both companies on the market offer a very similar product), zero production costs of companies and consumer indifference (due to the choice of manufacturer with unlimited capacity). Basic model also assumes one unit consumption in each node. We leave this assumption in the extended version.

The idea of spatial game is based on (Lopez and Čičková 2018). We will assume following: Let $V = \{1, 2, \dots, n\}$, $n \in \mathbb{Z}^+$ be the set of customers and let there be graph $G = (V, H)$ where V represents nodes of the graph and $H \subset V \times V$ represents set of the

edges $h_{ij} = (v_i, v_j)$ from node v_i to node v_j , while for each oriented edge h_{ij} there is assigned real number $o(h_{ij})$ referred to as a valuation or value h_{ij} . Spatial game was formulated in so-called full-valued graph $\bar{G} = (V, \bar{H})$ with the same set of nodes as graph G , where \bar{H} is set of the edges between each pair of nodes v_i and v_j , while their valuation is equal to the minimum price between nodes v_i and v_j of the original graph, $i, j \in V$. It is often assumed that $o(h_{ij}) = d_{ij}$ where d_{ij} represents the minimum distance (the shortest path length) between the nodes v_i and v_j , then the matrix $\mathbf{D}_{n \times n} = \{d_{ij}\}$ is the matrix of the shortest distances between the nodes v_i and v_j .

We assume there are two companies (players) $P = \{1, 2\}$, offering a homogeneous product (good or service) in unlimited quantities, and these companies can place their branches in just one of the nodes, i.e., in any element of the set $V = \{1, 2, \dots, n\}$, which are also the locations of customers. Although both players offer identical products in unlimited quantities, the price of the products may be different. Let p_1 be the price of the product of player 1 and p_2 the price of the product of player 2. Each customer makes a purchase from any company (service is always carried out, i.e., lost demand is not considered). When choosing a company, customers consider the total cost of purchasing the product, which consists of the price of the product and the cost of transportation to the selected company. Transport costs are expressed as t per unit distance. If player 1 places his store in the i th node ($i \in V$) and player 2 places his store in the j th node ($j \in V$), player 1 gets the customer from the k th node ($k \in V$) only if $t * d_{ki} + p_1 < t * d_{kj} + p_2$, while $t * d_{ki} + p_1 = n_{ij}^{(1)}$ and $t * d_{ki} + p_2 = n_{ij}^{(2)}$ are elements of cost matrices of customers $\mathbf{N}^{(1)}$ and $\mathbf{N}^{(2)}$. Otherwise, the customer from the i th node is served by player 2. If $t * d_{ki} + p_1 = t * d_{kj} + p_2$, players share the demand equally.

The basic situation, represented by a *fixed price model*, is where the prices of both products are known in advance and based on the above assumptions. Thus, elements of the payment matrix of player 1 $\mathbf{A} = (a_{ij}), i, j \in V$, (where the element a_{ij} represents the number of served nodes of player 1 in the case if player 1 operates in the i th node and the opponent in the j th node), are explicitly calculated. The elements of matrix \mathbf{A} are quantified based on the stated elements of cost matrices of consumers as follows:

$$a_{ij} = \begin{cases} a_{ij} + 1, & \text{if } n_{ij}^{(1)} < n_{ij}^{(2)} \\ a_{ij} + 0.5, & \text{if } n_{ij}^{(1)} = n_{ij}^{(2)} \end{cases}$$

Such matrix characterizes a given game with a constant sum (where the game constant is equal to the number of nodes of the graph G). Equilibrium strategies can then be determined in a standard way based on the *min-max* principle. If the use of this approach does not lead to an equilibrium strategy, equilibrium strategies can be determined based on linear programming problem.

When determining the best response to an opponent's price, the price of the goods of the second player p_2 is known in advance. The price of the goods of the first player p_1 is in this model variable and the player would like to set it in a way to maximize his

revenues. It is obvious that under such assumptions the elements of the payment matrix of player 1 will depend on the value of p_1 .

The relationship between the elements of the payment matrix and the price p_1 is:

$$a_{ij}(p_1) = \sum_{i \in V} \frac{\text{sgn}(t * d_{kj} + p_2 - (t * d_{ki} + p_1)) + 1}{2}$$

Now it is possible to express the pricing for player 1 by this mathematical model:

$$\begin{aligned} w * p_1 &\rightarrow \max \\ a_{ij}(p_1) &= \sum_{i \in V} \frac{\text{sgn}(t * d_{kj} + p_2 - (t * d_{ki} + p_1)) + 1}{2} \\ \sum_{i \in V} a_{ij} x_i &\geq w, j \in V \\ \sum_{i \in V} x_i &= 1 \end{aligned}$$

The problem is discontinuity of the Signum function here, but the function can be replaced by binary programming problem. The new model includes following sets and parameters:

- $n \in Z^+$ – number of nodes
- $V = \{1, 2, \dots, n\}$ – set of all nodes
- $d_{ij} \geq 0, i, j \in V$ – shortest distance between nodes i and j
- $t > 0$ – costs per unit distance
- $p^{(2)} > 0$ – price of opponent's (player 2) product
- M – big positive number
- ε – small positive number.

Variables:

- $w \in \langle 0, n \rangle$ – number of served nodes
- $x_i \in \langle 0, 1 \rangle, i \in V$ – i th mixed strategy of player
- $p^{(1)} > 0$ – price of product of player 1
- $a_{ij} \in \langle 0, n \rangle, i, j \in V$ – payment matrix of player 1
- $b_{kij}^{(1)} \in \{0, 1\}; k, i, j \in V,$
- $b_{kij}^{(2)} \in \{0, 1\}; k, i, j \in V,$
- $b_{kij} \in \langle -1, 1 \rangle; k, i, j \in V.$

This situation can be described by this mathematical model:

$$w * p^{(1)} \rightarrow \max \quad (1)$$

$$t * d_{kj} + p^{(2)} - (t * d_{ki} + p^{(1)}) \leq M * b_{kij}^{(1)}; k, i, j \in V \quad (2)$$

$$t * d_{kj} + p^{(2)} - (t * d_{ki} + p^{(1)}) \geq -M * b_{kij}^{(2)}; k, i, j \in V \quad (3)$$

$$b_{kij}^{(1)} + b_{kij}^{(2)} \leq 1; k, i, j \in V \quad (4)$$

$$b_{kij} = b_{kij}^{(1)} - b_{kij}^{(2)}; k, i, j \in V \quad (5)$$

$$b_{kij}^{(1)} * (t * d_{kj} + p^{(2)} - (t * d_{ki} + p^{(1)})) \geq \varepsilon * b_{kij}^{(1)}; k, i, j \in V \quad (6)$$

$$b_{kij}^{(2)} * (t * d_{kj} + p^{(2)} - (t * d_{ki} + p^{(1)})) \leq -\varepsilon * b_{kij}^{(2)}; k, i, j \in V \quad (7)$$

$$a_{ij} = \frac{\sum_{k \in V} (b_{kij} + 1)}{2}; i, j \in V \quad (8)$$

$$w \leq \sum_{i \in V} a_{ij} * x_i; i, j \in V \quad (9)$$

$$\sum_{i \in V} x_i = 1 \quad (10)$$

The objective function (1) represents the revenue function of player 1. Equations (2) to (8) are used to determine the payment matrix of player 1. Equations (9) and (10) make it possible to determine the equilibrium mixed strategy of player 1.

3.1 Best response model with limited capacity of duopolist and different demands of nodes

In the previous section, we considered unit demand of individual nodes of the graph. It is obvious that a player's interest in each node is generally conditioned by the "size" of the demand of a given node, while in terms of this criterion, some nodes are more interesting for the player than the others. The size of demand can be related, for example, to the number of inhabitants. We will also leave the assumption of an unlimited offer and assume the limited offer of players. Considering the limited demand of nodes, which is given by the vector $\mathbf{g} = (g_i), i \in V$, let us also consider constraints on supply side. We will mark the maximum offered quantity of goods for player 1 as k_1 and the maximum offered quantity of goods for player 2 as k_2 . Consumer demand will then be distributed among the players based on the following rules: the consumer seeks to minimize his costs. However, if the player's capacity is not sufficient, he must, despite the increased costs, move to the opponent.

When solving such game, the total capacity on the supply side needs to be considered. If it is possible to satisfy the whole demand of the nodes, that means if $k_1 + k_2 \geq \sum_{i \in V} g_i$, it is possible to use a game with constant sum. If it is not possible to satisfy the whole demand of the nodes, that means if $k_1 + k_2 < \sum_{i \in V} g_i$, any node would be equally advantageous for both players ($\mathbf{A}_{n \times n} = (k_1), \mathbf{B}_{n \times n} = (k_2)$).

In case the prices of duopolists are known in advance (case of the *fixed price model*) and it is possible to satisfy the whole demand of the nodes ($k_1 + k_2 \geq \sum_{i \in V} g_i$), the calculation of elements of payment matrix of player 1 (\mathbf{A}) and payment matrix of player 2 (\mathbf{B}) can be written in the form of the following procedure:

LET $V = \{1, 2, \dots, n\}$, $\mathbf{D}_{n \times n} = (d_{ij})$, t , p_1, p_2 , $\mathbf{g}_n = (g_i)$, k_1, k_2
LOOP ($i, j \in V$) **DO**

```

 $n_{ij}^{(1)} = t * d_{ij} + p_1;$ 
 $n_{ij}^{(2)} = t * d_{ij} + p_2;$ 
 $a_{ij} = 0;$ 
 $b_{ij} = 0;$ 
LOOP ( $k, i, j \in V$ ) DO
IF  $n_{ki}^{(1)} < n_{kj}^{(2)}$  DO  $a_{ij} = a_{ij} + g_k;$ 
ELSEIF  $n_{ki}^{(1)} = n_{kj}^{(2)}$  DO  $a_{ij} = a_{ij} + 0.5g_k, b_{ji} = b_{ji} + 0.5g_k;$ 
ELSEIF  $n_{ki}^{(1)} > n_{kj}^{(2)}$  DO  $b_{ji} = b_{ji} + g_k;$ 
ENDIF
LOOP ( $i, j \in V$ ) DO
IF  $a_{ij} - k_1 > 0$  DO  $a_{ij} = k_1, b_{ji} = b_{ji} + a_{ij} - k_1;$ 
ENDIF
IF  $b_{ji} - k_2 > 0$  DO  $b_{ji} = k_2, a_{ij} = a_{ij} + b_{ji} - k_2;$ 
ENDIF

```

The determination of the equilibrium price of player as the best response to the set price of the opponent is different now. Unlike the basic model, we will consider the size of the demand of individual nodes. Let the demand of the nodes be given by vector $\mathbf{g} = (g_i), i \in V$ and the equation (17) will be replaced by equation:

$$a_{ij} \leq \frac{\sum_{k \in V} (b_{kij} + 1)}{2} * g_k; i, j \in V \quad (11)$$

We consider the case where duopolist knows the limit of his capacity, but he does not know the limit of his opponent (he considers it to be large enough to satisfy the whole demand).

Then the elements of matrix \mathbf{A} must meet the constraints:

$$a_{ij} \leq k_1; i, j \in V \quad (12)$$

These relations will ensure (together with equations (1)-(7), (9)-(11)) the setting of such values of matrix \mathbf{A} , that also meet the capacity limit for player 1.

4 Numerical example

Further illustrative example is inspired by the administrative division of the Slovak Republic. Let the nodes of graph G represent potential regions - the so-called catchment areas for the construction of new branches of two companies operating in the market in the position of two strong players ($P = \{1,2\}$). By regions (catchment areas) we will understand the regions of the Slovak Republic, represented by individual regional cities: 1-Banská Bystrica, 2-Bratislava, 3-Košice, 4-Nitra, 5-Prešov, 6-Trenčín, 7-Trnava and 8- Žilina. These 8 cities therefore represent the nodes of the graph $G, V = \{1,2, \dots 8\}$.

The demand of individual nodes is equal to the number of customers of these nodes and is represented by the vector:

$$\mathbf{g}^T = (112; 115; 122; 122; 119; 108; 88; 109)$$

The numbers are given in thousands and rounded. This means that, for example, in the first node (i.e., in the city of Banská Bystrica) there are currently 160 thousand potential customers, whom companies can get and sell their products to. In the second node (Bratislava) there are 33 thousand more of them, that means 115 thousand customers and in the third node (Košice) 189 thousand. This continues until the last, eighth node, which corresponds to the city of Žilina and where there are currently 165 thousand potential customers.

Each of these consumers make purchase from one of the two companies (players) being aware of the costs they must bear if they decide to buy from a selected company. Based on these costs, he decides who from to buy the goods. Although the companies offer homogeneous services, their prices are not the same. However, in addition to the price of the goods, the total costs of the customers also include transport costs. Those per kilometre of distance are represented by t . We will consider different unit transport costs. It is clear, that the value of these costs also represents the "weight" between the player's price and the distance to go to the place of service. The matrix $\mathbf{D} = d(i, j)$, $i, j \in V$ is also known, is representing the shortest distances between individual regional cities and has the following form:

$$\mathbf{D} = \begin{bmatrix} 0 & 207 & 213 & 119 & 248 & 142 & 165 & 89 \\ 207 & 0 & 420 & 88 & 419 & 125 & 47 & 198 \\ 213 & 420 & 0 & 332 & 35 & 329 & 378 & 256 \\ 119 & 88 & 332 & 0 & 361 & 85 & 46 & 140 \\ 248 & 419 & 35 & 361 & 0 & 294 & 372 & 221 \\ 142 & 125 & 329 & 85 & 294 & 0 & 78 & 73 \\ 165 & 47 & 378 & 46 & 372 & 78 & 0 & 151 \\ 89 & 198 & 256 & 140 & 221 & 73 & 151 & 0 \end{bmatrix}$$

Let us have a situation in which the pre-known unit price of the second player's product will be $p_2 = 100$. However, let the consumer know that his price cannot differ from the other player's price by more than 50%. The product price of the player must be within interval $\langle p_1^{(lo)}; p_1^{(up)} \rangle$ where $p_1^{(lo)} = 50$ and $p_1^{(up)} = 150$. Let the unit costs per kilometre be $t=0.2$ and limited capacity of player 1 be 600. That means that he knows he cannot serve more than 600 units of demands, but he does not know the capacity of the opponent (he considers it to be large enough).

Based on our model we obtain these results, solved by GAMS and its solver Couenne (this is a problem of mixed integer nonlinear programming (MINLP)). The calculated price of the first player's product at the known price $p_2 = 100$ is at level $p_1 = 99.999$, at which he achieves revenues of 52,172.095, while serving almost 522 customers. The solution also gives the final payment matrix \mathbf{A} :

$$A = \begin{bmatrix} 600 & 462 & 600 & 462 & 600 & 353 & 462 & 356 \\ 433 & 600 & 600 & 115 & 600 & 203 & 115 & 325 \\ 241 & 241 & 600 & 241 & 356 & 241 & 241 & 241 \\ 433 & 600 & 600 & 600 & 600 & 437 & 584 & 325 \\ 241 & 241 & 539 & 241 & 600 & 241 & 241 & 241 \\ 542 & 600 & 600 & 458 & 600 & 600 & 570 & 433 \\ 433 & 600 & 600 & 311 & 600 & 325 & 600 & 325 \\ 539 & 570 & 600 & 570 & 600 & 462 & 570 & 600 \end{bmatrix}$$

The accuracy of the calculation can be verified using a *fixed price model* (where prices of both players are given in advance).

Strategy of the first player is then given by the vector $\mathbf{x}^T = (0; 0; 0; 0.01968; 0; 0.43633; 0; 0.54399)$. Interpretation of mixed strategies (the probability of strategy selection) is generally difficult. If it was possible to change the place of service (for example, daily revenues, distribution of the number of employees or distribution of a divisible commodity), player 1 should perform 1.968% of service in node 4, 43.633% in node 6 and 54.399% in node 8.

5 Conclusion

Every company wants to be successful in operating in the market. To gain its aims, it needs to be competitive and make strategic decisions like choosing location or price of its products. Spatial competition models are generally discussed topic focused primarily on the analysis of location decisions of players who aim to maximize their revenues. Game theory tools, due to their competitive nature, can support the decision analysis.

In our article we presented specific situation of spatial game dealing with placement on the graph, in which two companies operating in the market make simultaneous decisions about locations of their branches. At the same time, one of the two companies also decide on the price of its products while the price of his opponent is known in advance. That means, the price is a variable in the model and the duopolist tries to set it in a way to maximize his revenues based on the best response. Offer of this duopolist is considered to be limited. The demand, located in the nodes and represented by indifferent customers, is divided among duopolists and we assumed it to be different in each node. The duopolists compete to attract their potential customers, who choose one of them based on their total costs, consisting of product price and shipping costs. To analyze this situation zero-sum games can be used. The situation we also presented on numerical example where nodes represented regional cities of Slovak Republic, while demands of these cities were related to the number of their inhabitants. For finding optimal solution we used GAMS and its solver Couenne.

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Effects of the pandemic on employees' wages in the Slovak Republic

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Abstract. The present paper analyzes the effects of the COVID-19 pandemic on the labor market in terms of the impact on employees' wages. The labor market is one of the segments that has suffered the most from the pandemic. The year-on-year changes in the wage growth rate that can be analyzed clearly show how significantly the development of the Slovak economy has been slowed down. The pandemic ended several good times, when the world's economies prospered above average and pointed out weaknesses. Residents were not prepared for a decline or loss of their income. This paper will analyze the indicators of wages of employees in Slovakia and their year-on-year development.

Keywords: COVID-19, Labour Market, Wages

JEL classification: J30, J31, J33

1 Introduction

The COVID-19 pandemic has been affecting our lives for a year and a half. Its effects can be monitored in many areas. The most important area is, of course, the health of the population, because the most dangerous weapon of this virus is the victims of human lives. From an economic point of view, the effects of the pandemic can be monitored, especially in the labor market, which is undergoing significant changes. The pandemic itself ended many years of carefree economic growth. It has hit us unprepared and has caused devastating changes in many areas of the national economy. An example is the tourism and gastronomy sector, which has suffered significantly due to pandemic restrictions. Employers stopped hiring new employees and some decided to lay off. Seasonal employees who worked for their contractors by agreement were affected the most. Thus, from an economic point of view, the pandemic affected the income area of the population the most. Some had to ask for a deferral of their loan repayments, others had to spend their several annual savings. The longer the period since the outbreak of the pandemic, the more relevant the data analyzed on the effects of the pandemic and show us the consequences of this crisis. When analyzing the wage area, it is necessary

to consider that in the national economy, labor income is a decisive source of livelihood for most households. Author Rievajová (2016) describes the importance of wages as follows: In the national economy, labor incomes are a crucial source of livelihood and social security for most households.¹ In this article, the author discusses the impact of the COVID-19 pandemic in terms of its impact on employees' wages.

1.1 Methodology

For the purposes of the presented paper, the author processed a set of data on the development of wage earnings in the Slovak Republic in the period 2018 – 2021 (1st quartal) - ISCP² Labor Price Information System 1-04. Statistics from the ISCP information system are based on the widest set of respondents, data are obtained directly from employers in the form of electronic collection and are therefore the most representative and objective statistical basis for analyzing wage differentiation and employment developments in the labor market, especially in terms of job structure.

For the purposes of the analysis, the author processed the above statistical data and evaluated them in the following structure:

1. Annual comparison of the development of the monthly wage in the Slovak Republic (comparison of data on the development of the average gross monthly wage and the median for the period 1Q 2018, 1Q 2019, 1Q 2020 and 1Q 2021). Wage development recorded as "Year-on-year difference in the average monthly wage"
2. Annual comparison of the development of the "Benefits and bonuses" wage component as part of the average gross monthly wage (evaluation of the percentage share of this wage component in the total wage to point out the declining share as a result of a pandemic)
3. Annual comparison of the development of the average gross monthly wage in the Slovak Republic divided into regions (the aim is to evaluate the percentage change in the amount of wage for the pandemic period). Comparison period: 1Q 2021 vs. 1Q 2020.
4. Annual comparison of the development of the average gross monthly wage by industry of the SK NACE Rev. 2 (The statistical classification of economic activities is intended to categorize data that relate to an economic entity as a statistical unit.)³
5. Analysis of the year-on-year change within the average gross monthly wage of individual employment subgroups (comparison of employment groups with the highest decrease in wages and the highest increase in wages for the period 1Q 2021 vs. 1Q 2020).

¹RIEVAJOVÁ, Eva, Eva PONGRÁCZOVÁ a Roman KLIMKO. Trh práce a politika zamestnanosti. 2. preprac. vyd. Bratislava: Vydavateľstvo EKONÓM, 2016. [16,57 AH]. ISBN 978-80-225-4356-9, s. 123.

² ISCP – Informačný systém o cene práce (in Slovak)

³ STATISTICAL CLASSIFICATION OF ECONOMIC ACTIVITIES SK NACE Rev. 2; Available at: https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2007/306/vyhlasene_znenie.html

2 Development and changes in the labor market in terms of wages of employees

2.1 Year-on-year changes in employees' wages

The effects of the COVID-19 pandemic can be traced from several areas. One of them is the area of remuneration and wages. The year-on-year comparison of the gross average monthly wage provides an accurate picture of how the pandemic affected employees' wages. The Slovak Republic has experienced very good times in recent years, which have been reflected in a declining unemployment rate at a record level, a rapidly growing increase in average wages in all sectors and a shortage of skilled labor. The Table 1 shows that until the pandemic period, the increase in the average monthly wage was at the level of about 6 to 7 %, which in real terms represents a difference of about 80 EUR. The median monthly gross wage expresses the division of the working population into two exact halves. Thus, it can be argued that 50 % of the working population of the Slovak Republic earned in the first quarter of 2021 an average gross monthly wage of up to EUR 1,101.82. The remaining half of the working population earns more than this amount per month.

A pandemic has been affecting our lives for more than a year and a half. The longer the period since the outbreak of the pandemic, the more relevant data on the effects of the pandemic will be able to be processed. In this case, the break that occurred after the outbreak of the pandemic could be observed. The year-on-year growth rate of the average gross monthly wage was 4.92 % in the first quarter of 2021, which is a decrease of almost 3 % compared to the years before the pandemic. Although the average gross monthly wages of employees grew, the pace of their growth was not as the Slovaks were used to before the pandemic.

Table 7. Development of the average gross monthly wage and median in the Slovak Republic

	1Q 2018	1Q 2019	1Q 2020	1Q 2021
Median monthly gross wage	903,51 €	977,70 €	1 051,48 €	1 101,82 €
Average gross monthly wage	1 115,25 €	1 187,07 €	1 272,24 €	1 334,79 €
Year-on-year difference in the average monthly wage		106,44 %	107,17 %	104,92 %

Source: Štvrťročný výkaz o cene práce ISCP (MPSVR SR) 1-04, author's processing

An interesting component of the wage structure is "benefits and bonuses", which are a variable component of wages. Their amount is decided by the employee's performance and is often conditioned by a decision of the company's management. In good times, when companies are doing well, it is possible to observe a high share of this component in the total average wage of an employee. An example of this is the Table 2, according to which "benefits and bonuses" accounted for about 10 % of an employee's total gross salary. During the pandemic period, a year-on-year decrease in

this indicator can be observed. Already in the first quarter of 2020, the share of bonuses and rewards decreased to the level of 8,78 %, and this trend continued throughout the year in which the pandemic began.

Table 2. Benefits and bonuses as a share of the average gross monthly wage

	Average gross monthly wage	of this: Benefits and bonuses	Percentage share of benefits and bonuses in the average gross monthly wage
1Q 2021	1 335 EUR	117 EUR	8,73 %
1Q 2020	1 272 EUR	112 EUR	8,78 %
1Q 2019	1 187 EUR	115 EUR	9,68 %
1Q 2018	1 115 EUR	114 EUR	10,26 %

Source: Štvrťročný výkaz o cene práce ISCP (MPSVR SR) 1-04, author's processing

In terms of wage remuneration according to the regional breakdown, an interesting situation can be observed. The Bratislava Region, as the most developed region of the Slovak Republic (it also accounts for the highest wage⁴), has long shown a significantly higher standard of living of the population in terms of their income. However, during a pandemic, the rate of wage growth is highest in the regions with the lowest wage earnings. For comparison, while in the Bratislava region there was an increase in the average wage of employees by 3,20 %, in the Košice region it was more than double this value (year-on-year change 1Q 2021 vs. 1Q 2020). In this respect follow Table 3 below (the annual development of the average gross monthly wage broken down by region of the Slovak republic).

Table 3. Development of the average gross monthly wage by region

	1Q 2021	1Q 2020	1Q 2019	1Q 2018	Difference 1Q 2021 vs. 1Q 2020
Average gross monthly wage	1 335 EUR	1 272 EUR	1 187 EUR	1 115 EUR	4,92 %
Bratislava Region	1 702 EUR	1 650 EUR	1 568 EUR	1 486 EUR	3,20 %
Trnava Region	1 263 EUR	1 196 EUR	1 110 EUR	1 042 EUR	5,58 %
Trenčín Region	1 262 EUR	1 187 EUR	1 105 EUR	1 036 EUR	6,33 %
Nitra Region	1 178 EUR	1 136 EUR	1 045 EUR	977 EUR	3,73 %
Žilina Region	1 251 EUR	1 182 EUR	1 095 EUR	1 020 EUR	5,86 %

⁴ European Commission, Internal Market, Industry, Entrepreneurship and SMEs. Bratislava region. Available at: <https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/bratislava-region>

	1Q 2021	1Q 2020	1Q 2019	1Q 2018	Difference 1Q 2021 vs. 1Q 2020
Banská Bystrica Region	1 170 EUR	1 114 EUR	1 021 EUR	959 EUR	5,03 %
Prešov Region	1 091 EUR	1 026 EUR	949 EUR	879 EUR	6,31 %
Košice Region	1 261 EUR	1 169 EUR	1 102 EUR	1 044 EUR	7,86 %

Source: Štvrťročný výkaz o cene práce ISCP (MPSVR SR) 1-04, author's processing

A comparison of 1Q 2021 and 1Q 2020 (Table 4) shows that changes in remuneration were filled by various selected sectors of the national economy. While in a sector such as Human health and social work activities, the average wage was higher by more than EUR 196 year-on-year compared to the same period in 2020, in the Accommodation and food service activities sector there was almost no increase in wages.

Table 4. Development of the average gross monthly wage according to the classification of industries SK NACE Rev. 2

	1Q 2021	1Q 2020	1Q 2019	1Q 2018	Difference 1Q 2021 vs. 1Q 2020
NACE classification / average gross monthly wage	1 335 EUR	1 272 EUR	1 187 EUR	1 115 EUR	
Q Human health and social work activities	1 505 EUR	1 309 EUR	1 193 EUR	1 085 EUR	196 EUR
N Administrative and support service activities	1 123 EUR	1 016 EUR	967 EUR	959 EUR	107 EUR
F Construction	1 168 EUR	1 076 EUR	1 054 EUR	992 EUR	92 EUR
I Accommodation and food service activities	766 EUR	794 EUR	726 EUR	662 EUR	-29 EUR
D Electricity, gas, steam and air conditioning supply	2 083 EUR	2 125 EUR	1 888 EUR	1 746 EUR	-42 EUR
L Real estate activities	1 184 EUR	1 239 EUR	1 074 EUR	1 077 EUR	-56 EUR

Source: Štvrťročný výkaz o cene práce ISCP (MPSVR SR) 1-04, author's processing

2.2 The most significant effects of the pandemic in terms of sectors of the national economy

The pandemic affected mainly the art world and the gastrosector. Theaters, cinemas, museums, galleries were closed and the ban on gatherings also did not contribute to their development. The year 2020 can therefore be considered one of the worst even for restaurants, bars and hotels that have been closed for many months. In some jobs in these sectors, there was also a year-on-year decline in wages. The average monthly

salary of actors or musicians, singers and composers fell by more than 18 % year-on-year, but dancers and choreographers also got worse by 14%. The salaries of chefs and bartenders fell by an average of 8 %, respectively 5%. The growth of wages of waiters and sommelier slowed from 12 % last year to 0,5 % this year. The coronary crisis also affected employees in higher positions. In the first quarter of this year, managers in accommodation establishments earned on average almost 9 % less than in the same period last year. The above information is given in Table 5.

Table 5. Year-on-year decrease in the average gross monthly wage in selected groups of employment

EMPLOYMENT SUBGROUP	AVERAGE GROSS MONTHLY WAGE 1Q 2021	YEAR-ON-YEAR DECREASE IN AVERAGE GROSS WAGE IN %)
Musicians, singers and composers	1 022 EUR	-18 %
Actors	989 EUR	-18 %
Dancers and choreographers	1 093 EUR	-14 %
Managers (managers) in accommodation facilities	1 535 EUR	-9 %
Bartenders	737 EUR	-8 %
Chefs	825 EUR	-5 %

Source: Štvrtročný výkaz o cene práce ISCP (MPSVR SR) 1-04, author's processing

2.3 Medical workers' wages rose sharply

The opposite development of wages can be observed in health care. High surcharges for medical staff who worked in the front line and in red covid zones were reflected in extreme wage increases. The healthcare sector recorded a year-on-year increase in the average gross monthly wage at the level of 15 %. In the first quarter of this year, the wages of specialists in hygiene, public health and occupational health increased the most. They improved by 48 % year-on-year. Compared to the first quarter of last year, personal health care workers earned almost a third more. Nursing specialists and nurses had an average of 28 %, respectively, on the payroll 23 % more than in the first quarter of last year. As for wages, their growth cannot be complained about even by general practitioners or specialist doctors, who earned an average of 18 % in the first quarter, respectively 10 % more than in the same period last year. The following Table 6 describes the highest wage increases in the pandemic period.

Table 6. Year-on-year increase in the average gross monthly wage in selected groups of employment

EMPLOYMENT SUBGROUP	AVERAGE GROSS MONTHLY WAGE 1Q 2021	YEAR-ON-YEAR INCREASE IN AVERAGE GROSS WAGE IN %
Hygiene, public health and occupational health specialists	1 575 EUR	increase 48 %
Personal health care workers	1 173 EUR	increase 32 %
Nursing specialists	1 788 EUR	increase 28 %
Medical assistants	1 234 EUR	increase 23 %
General practitioners	2 223 EUR	increase 18 %
Doctors specialists	2 571 EUR	increase 10 %

Source: Štvrťročný výkaz o cene práce ISCP (MPSVR SR) 1-04, author's processing

3 Conclusions and policy implications

Based on the data published in this paper, it can be confirmed that the COVID-19 pandemic significantly affected the domestic labor market in the Slovak Republic. The average growth rate of employees' wages has decreased significantly, but significant differences can be observed in terms of the breakdown into sectors of the national economy. There are sectors where a significantly high year-on-year increase in the average wage can be observed. This is particularly the health sector, which can be interpreted as a consequence of the established benefits and bonuses for employees in this sector during a pandemic. On the contrary, the most significant decline in average monthly wages was recorded in sectors such as real estate activities, or in accommodation and food service activities in general, which were mainly affected by government regulations and restrictions. The Spring 2021 Economic Forecast projects that growth rates will continue to vary across the EU, but all Member States should see their economies return to pre-crisis levels by the end of 2022.⁵

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Strategy of ethical approach in neuromarketing

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Abstract. Traditional demand-based marketing research methods fail - because they depend on respondents' willingness to describe their feelings. Neuromarketing focuses on directly examining how respondents feel and what they think about a product or advertisement. This paper discusses the evolving and potential field of neuromarketing. Respondents, participants in the research are human beings and have the right to their privacy and protection of their own identity. The ambition of the contribution is to point out the possibilities of applying the strategy with regard to ethical principles in neuromarketing in the conditions of the Slovak republic.

Keywords: Strategy, ethical approach, neuroscience, neuromarketing, market research

JEL classification: *M31, M39*

1 Neuromarketing and its place in marketing research

The use of neuromarketing activities has often provoked heated debate, one side, critics in this case believe that neuromarketing tools in this situation may affect consumers' ability to choose not to choose the products on the market. This may mean that consumers would be prone to respond in a different way than they would naturally, simply put, they would become easy victims of advertising campaigns. (Wilson, Gaines Hill, 2008).

On the other hand, in addition to critics, we also know other personalities such as Lindstrom (2009a, 2009b) and Dooley (2010), whom we perceive through the optics of proponents of neuromarketing tools. They mainly discuss the benefits of neuromarketing methods. These authors argue that consumers could only benefit from the introduction of neuromarketing methods in consumer and marketing research. Consumer decisions could be simpler rather than more manipulative by introducing these methods.

In the research itself, it is important to consider the subject of the research, namely the consumers - respondents. Those as human beings have their fundamental rights, principles and values, which must not be denied them, and it is important to respect them. The purpose of this paper is to clarify neuromarketing in comparison with traditional marketing methods.

The main goal of the paper is to clarify neuromarketing and identify its specifics with regard to the specifics of traditional marketing methods. We specified the main goal into two partial goals:

- point out the importance of an ethical approach to neuromarketing,
- propose a strategy for an ethical approach in neuromarketing.

Based on the analysis of resources, we were able to identify several concepts of neuromarketing. Neuromarketing has been described as a field of research (Murphy et al., 2008), a field of study (Lee et al., 2007 and Eser, 2011) & a scientific approach (Senior & Lee, 2008), a field of applied neuroscience (neuroeconomics, neuropsychology, neurobusiness, consumer neuroscience) (Perrachione, 2008), and the marketing part (Fisher et al., 2010), the interconnection of systems of perception (Butler, 2008), the sub-area of neuroeconomics (Hubert & Kenning, 2008).

A large group of authors perceive neuromarketing primarily as a means of acquiring scientific knowledge (Lee et al., 2007; Fisher et al., 2010). Other authors perceive neuromarketing as a potential commercial marketing tool (Perrachione, 2008; Fugate, 2007). We can therefore clearly state that Neuromarketing already has an unquestionable place in marketing studies. As the subject of the neuromarketing research is the consumer himself, his research must respect his rights and adapt the research process itself.

Based on the analysis of the literature, we can state that neuromarketing uses all the latest devices and resources for brain scanning, from understanding the process of consumer decision-making (Eser et al., 2011). Schneider & Woolgar, 2012). Marketing is basically the only thing - understanding consumer behavior.

The second very important thing is the way and why customers choose products, it is primarily a consumer choice. What are the primary reasons why customers make decisions? Neuromarketing can play a crucial role in determining the likelihood and unlikely of purchasing decisions. Neuromarketing has also been identified as a way to shape and design or adapt companies' marketing strategies (Eser et al., 2011).

Of course, there have been several definitions of neuromarketing since 2007, and we are trying to approach in this section those that we think describe this word perfectly. Thus, neuromarketing examines areas in the brain that are activated during various marketing stimuli and cognitive processes. It is for this reason that marketing as a technique and method has the greatest potential to describe the triggers of purchasing decisions and to describe the answers to the questions why customers buy and why the products in question. Therefore, the development of effective social campaigns from the social marketing environment, such as promoting the use of seat belts in cars while driving or quitting cigarette smoking, seems to be an ideal form of neuromarketing application. (Orzan et al., 2012).

2 Methodology

The aim of the paper is to define neuromarketing and clarify it in confrontation with traditional marketing methods. The second important goal is to point out the importance of an ethical approach in the conditions of neuromarketing and to propose a strategy of an ethical approach to market research in neuromarketing.

The research took place in two stages. In the first, we looked for information in articles, blogs, and websites of neuromarketing companies. Non-academic journals and marketing blogs were selected using Google's blog search tool. Articles and blogs dealing with the concept of neuromarketing were selected. He culminated the first step by understanding the topic and identifying new areas of research for the next phase. A recurring point was the definition of neuromarketing as a new technique for market research.

In the second step, only peer-reviewed academic articles were analyzed. The EBSCOhost research platform was used to access the articles, which provided access to more than 320 databases. With regard to the subject of research, we have defined keywords: neuromarketing, neuroscience, ethical approach, marketing. In total, we analyzed 21 academic articles.

To prepare the paper, we used the analysis of systematically collected empirical material on the issue. We have defined the basic concepts by the method of analysis, synthesis and abstraction. When evaluating neuromarketing methods, we used the method of comparison.

3 Traditional methods of marketing research in comparison with neuromarketing methods

Neuromarketing is recommended as an important and revolutionary form of marketing research. Fisher et al. (2010) evaluate neuromarketing as a type of qualitative research that yields graphical and quantifiable results. Bercea (2013) explains that it is difficult to classify research in this new field as qualitative or quantitative and that the types of equipment used and the research protocol adopted are determinants of this classification. Regardless, the importance of neuromarketing lies in its ability to evaluate emotional processes. Thus, this technique provides access to richer and less interested marketing knowledge than other traditional research techniques, such as surveys and qualitative research (Murphy et al., 2008).

Neuroscientific methods are ahead of traditional marketing research methods for understanding and examining consumer behavior. This enhanced understanding allows managers to innovate and develop their products and processes across companies, gl

Very well-known methods of market research, or methods of questioning, whether online or in person, as well as methodologies and surveys of target groups and the creation of ideal staff representatives of consumers are full of limitations. The limitations are precisely what the survey respondents are able to allow us to do. Thus, the mentioned metrics really only measure what the respondents tell us and are willing to say about themselves. In the past, well-known researchers have often been able to

identify significant differences in research methodology between this intention and the actual behavior of respondents (Jamieson and Bass 1989).

Thus, this problem was discovered in the early beginnings of marketing science. The research method captures the respondent's stated intention towards the product, but the actual behavior can really be very different from what the respondent said in the research. Cognitive neuroscience techniques today offer a great opportunity to improve marketing methods and perhaps to redefine marketing through a deeper understanding of consumer behavior. The number of techniques available for studying cortical activity will help the marketer to better understand the motives for purchasing and thus save considerable funds that would not lead to successful steps in marketing. Individuals not only act according to their feelings, but many studies also show that they act under the influence of the expected rewards for decision-making in the short and long term. The combination of both research techniques and methods provides more valuable insights into consumer preferences and the consumer purchasing process (Hubert & Kenning, 2008).

4 Discussion

Neuromarketing has a very important place in the analyzed texts. The subject of research is always the consumer and his consumer behavior. Therefore, it is very important to pay special attention to him and create an approach that would not affect him in his actions.

4.1 Ethical approach in neuromarketing

Activities in the field of brain mechanisms have brought a very interesting interdisciplinary area, which we know today as neuroethics (Roskies, 2002). Neuroethics deals with social, moral or ethical issues, which are related, for example, to the implementation, but also the design of all neuroscientific experiments, as well as their impact on all existing legal, social and ethical issues.

The emergence of neuroethics is partly due to a growing sense of aversion and protest against technological devices such as functional magnetic resonance imaging or electroencephalogram, which uses neuromarketing. This area is often suspected of manipulative abuse, which results from reading consumers' thoughts and guiding their shopping options. Neuromarketing research has also been criticized for its impact on human dignity - speaking of the integrity of moral growth and the dignity of identity based on the set of rights of a part of the human being (Ulman et al., 2015) - as well as its potential violation of bioethical principles and individual values. They are autonomy, self-determination, confidentiality, and respect for private life (Ulman et al., 2015). Some responded to these claims by claiming that neuromarketing could not interpret consumer ideas or control individuals' purchasing opportunities.

According to several authors, neuromarketing is the application of neuroimaging and physiological tools to record the neural correlates of consumer behavior (eg decision-

making, emotions, attention and memory) against marketing incentives such as various brands and advertisements. (Alsharif, Salleh, Baharun, 2021)

Traditional research methods have been widely used as feedback to study consumer responses (eg, consumer decision-making) to marketing incentives such as advertising and branding (Harris, 2018). Such an assessment relies on awareness of consumer behavior and overlooks unconsciousness; thus, the discrepancy between what the consumer says and does, and here we come to the very turning point and identifying the difference between classical marketing methods and a new neuromarketing approach that can eliminate these differences or deviations. Traditional research methods provide inaccurate and unreliable information on consumer behavior (Alsharif, 2021; Alsharif, Salleh, Baharun and Effandi, 2020), leading to the conclusion that most products and advertisements fail in the basic setting of the marketing mix and marketing strategy (Jordao, 2017 Vecchiato, 2015). Therefore, most consumer behavior (eg, decision-making, perception) takes place unconsciously, which cannot be predicted by traditional research methods (Alsharif, Salleh, Baharun, & Effandi, 2021).

All used neuromarketing methods have their limits without a doubt. It is not only the instrumentation itself that matters, but also the staff and personnel who manage the research process (Fugate, 2007). Many authors still point to cases where neuromarketing researchers have tried to manipulate respondents in neuromarketing research by affecting their emotions (e.g., Wilson, Gaines, & Hill, 2008).

In neuromarketing research from the point of view of ethical approach, it is necessary to focus on three ethical areas:

- the degree of knowledge and understanding of the participants as to the objectives and possibilities of the experiments;
- transparency of research protocols, in particular as regards the implications of marketing strategies carried out by companies or other organizations;
- the creation of appropriate legislation to accompany the rapid development of this new discipline (Murphy et al., 2008).

Neuromarketing tools and practices fascinate the professional public on the one hand, but outrage the general public on the other hand and raise some ethical concerns. The most important problem with regard to the analysis of professional texts can be identified violations of respondents' privacy. Consumers believe that neuromarketing tools can read their minds (Hubert and Kenning, 2008). This would make consumers transparent to companies, which could at any time challenge their private decisions and force their preferred behavior and product choices (Fugate, 2007).

Another ethical issue in neuromarketing is the use of this technique for other purposes (Lee et al., 2007). When examining cognitive processes related to the consumption preferences of individuals, firms gain great power to influence purchasing decisions (Murphy et al., 2008 and Fisher et al., 2010). Many sources report a lack of ethics regarding the ability of neuromarketing to "create irresistible ads and products."

Neuromarketing has since moved significantly forward, and marketing agencies have begun to organize independent research, which is conducted in a very similar period at universities in all countries around the world, even in China (Molchanov, Yang, 2019). Private doctors already work in research agencies and universities, who can negate the previous objection. Neuromarketing would then pose a major threat to

consumers' autonomy, as it would remove their defense mechanisms. The above issues concern ethical approaches in neuromarketing.

It is therefore demonstrable that the positive impact of neuromarketing outweighs the possible unwanted negative effects that could endanger consumers. This is an important argument that may also play a role in the creation of new neuroscience, neuromarketing centers with different neuroimaging technologies. Such a space is certainly being created on the premises of the University of Economics in Bratislava. The connection between economics and neuroscience has great potential for the university's research activities.

Other authors also claim that neuromarketing has aroused criticism because doctors and academics work in marketing research companies. According to Dinu et al. (2010) it is possible to hide possible damage to the health of participants or negative aspects of marketing research, and therefore the results would be biased. From our point of view, there is room for the discovery of possible health problems of respondents, because the examined objects are analyzed in detail and doctors can discover hidden potential health problems. Following a consultation with the respondent's security and privacy, treatment of the identified problems can begin.

Of course, the use of scientific technologies to promote commercial interest is not inherently problematic, but the use of technology that examines the inner workings of the human brain, especially beyond what might reveal traditional behavioral studies, raises significant ethical concerns. These issues fall into two main categories:

- protection of various parties that may be harmed or abused by neuromarketing,
- protecting consumer autonomy (Murphy, Iles, & Reiner, 2008).

For some, neuromarketing raises worrying questions about the extent to which advertising agencies, marketing researchers, and their corporate clients should be able to intrude on consumer privacy, and the perceived power will allow them to manipulate consumer purchasing decisions (Lewis, 2007).

Introducing neuroimaging methods into an environment where the ultimate goal is to sell more products to the consumer can raise ethical issues. In the next section, we provide an overview of ethical issues that may arise:

- Businesses will be able to read consumer thoughts. This concern concerns the privacy of thoughts. Is it possible to use neuromarketing to find out the preferences of a person outside of a specific task? This concern can be alleviated by transparency of purpose: operators need to know what kind of efforts they are helping, and their data should only be used for that purpose.
- Private versus public preference information. Individuals must be able to control what they choose to disclose about their personal preferences. An invasion of privacy occurs when neuroimaging methods reveal private preferences that are outside the research question of neuromarketing research.
- The information will be used to discriminate against individuals or to misuse specific neurological traits found in a subset of individuals. Many people would find this tactic disgusting because it exploits a biological "weakness" that only exists in some people. Similarly, this information could be used to time upward price movements in product pricing in order to exploit individual weaknesses

that are known to coincide with specific biological conditions (for example, rising beverage prices when someone is known to be thirsty).

- Medium versus peripheral path of influence. The aim of the central route is to influence consumer preferences regarding the functional aspects of the product (for example, fewer calories in beer). The peripheral path tries to manipulate preferences through motifs that are peripherally related to the product (such as the sex of people in ads). Neuromarketing could potentially be used to increase both types of impact, but some find attempts to optimize the peripheral route more ethically questionable.
- Brain responses obtained from a small group of subjects will be used to generalize to a large population. This, of course, is constantly happening in the scientific literature. If neuromarketing data is used in a product design and the product injures someone, this is partly due to the setting up of neuromarketing research and poor evaluation of results. Particular attention should be paid to this, but it is not just about neuroscience research.
- Lack of regulation of traditional marketing methods, as they are not usually considered experimentation, nor are they subject to the supervision of various state institutions. For example, MRI scanning is approved in the United States by the US Food and Drug Administration (FDA) for clinical use, but because no diagnosis is made in the marketing environment, there is potential to circumvent FDA requirements. The emerging neuromarketing industry should make a good decision to adopt an industry standard of independent review. Clients should request it.
- Perception management. How will the public react when they find that neuromarketing research has been used in product design or product marketing? The public's response to genetically modified foods could provide an opinion, because we still live today at a time when the Sars-COV-2 virus vaccine was developed and people have adopted it. Acceptance of this form of human examination is also a prerequisite.
- Companies do not have to be primarily concerned with the best interests of the consumer. Companies and consumers maintain complex relationships in which some of their goals are compatible while others are in conflict. On the one hand, companies strive to design, manufacture and sell products that customers seek to buy, leading to the achievement of compatible goals for the benefit of both parties. On the other hand, companies also focus on maximizing their short-term or long-term profits, sometimes to the detriment of their consumers. Like marketing itself, an understanding of consumer preferences can be applied to goals that are in the best interests of society and their consumers, or to goals that are in the interests of society and to the detriment of their consumers. What approach neuromarketers choose is an open question.

4.2 Ethical approach in neuromarketing research

In order to reassure the public and to work in some way with potential discoveries on the one hand and moral beliefs on the other, we need to develop a special approach

that reflects these two values. This neuroetic approach would implement the use of all smaller micro- as well as larger non-invasive devices. In marketing research, we must adopt a framework that respects the privacy of respondents. Ethical issues can be exacerbated by the introduction of smaller diagnostic devices and nano-devices in all marketing practices. Small nanodevices have the advantage of being easy to carry, inconspicuous and often imperceptible to the naked eye. They can remove a sense of aversion and a deeper message of control over everyday consumers and consumer behavior, whether at home or in a store or business space, with the prospect of forcing people to consume products even if consumers do not directly want or seek them (Ariely & Berns, 2010).

Consumers have three main areas of interest when using their own data by companies, which we have described above:

- transparency,
- security,
- responsibility.

It is quite understandable that consumers with a growing sense of mistrust need a certain depth of understanding. When conducting marketing surveys, we should respect the control over the handling and handling of personal data about respondents. In this context, their demand for privacy is absolutely understandable. We perceive a growing argument that the new dimension and current in marketing - nanomarketing, which is a kind of link between marketing and the use of nanodevices, in assessing consumer attitudes and preferences, must clearly protect human dignity. It is also necessary to protect the privacy of respondents and neutrality, or the autonomy of consumers, and last but not least to protect groups of the most vulnerable people, such as the elderly - retired or young people, namely children of all categories.

Conati (2004) identified in his research that, for example, children perceive these devices very naturally and even think that these devices in neuromarketing are not disruptive for them. Nanomarketing devices, with their small size, have raised a number of questions as to whether they may not be a black tool for manipulating consumers or whether they can improve consumers' lifestyles by measuring them. The answers are clear. With the growing number of neuromarketing studies, we are clearing these concerns, and the study clearly states that neuromarketing and nanomarketing devices are beneficial to humans. For example, continuous real-time monitoring offered by portable nano-devices that can provide a better understanding and treatment of some compulsive messages, such as shopping addiction, alcohol, smoking, or gambling. In addition, thanks to the results of neuromarketing measurements, consumers have the opportunity to improve their shopping habits and make their shopping efficient. In the same way, thanks to neuromarketing measurements, they can get their emotions under control - they can identify an emotional state when they do not pay to enter the store, because they would miss their savings on unnecessary products. This particular code of conduct, if we can call it that, should also respect the protection of all vulnerable entities, especially children, the elderly, the mentally ill but also prisoners (Murphy et al., 2008). This established code of ethics must be based on the WMA Universal Declaration of Helsinki.

Third, ethical recommendations should include the dissemination of:

- data,
- experiments
- risks
- the benefits of experiments.

Fourth, all results obtained from neuromarketing experiments should be transparent and available to the public, both professional and in a certain version of the ordinary one. They should be professionally described in publications and in the form of reports made available in the mass media. In every respect in research, we must guarantee the privacy and anonymity of all respondents, because already in the initial phase of the research, it was agreed between researchers and respondents that all information will be for scientific purposes only (Slowther & Kleinman, 2009). It is not possible to further trade this data. In this context, another serious problem may arise, namely in the diagnosis of respondents' abnormal health. In case of finding an abnormal object on a healthy observed subject - the respondent is strongly recommended to consult this condition with a doctor who is a specific person from the project team, capable of consulting treatments or treatment procedure.

Our proposal for a strategy for an ethical approach in neuromarketing is to seek knowledge with respect to the truth. We divide the strategy of ethical approach to neuromarketing research into 4 basic phases:

- acquaintance with the legislation in the examined area,
- informing respondents about the objectives and risks of the research,
- acceptance of informed consents,
- protection of data and privacy of respondents.

At the beginning of the whole process, it is important that the research respondents are acquainted with the whole research process and the possible risks, if any will have to be taken during the research. The basis of the information provided is informed consent. Before entering the research, each research participant should be clearly and intelligibly informed of:

- the objectives of the specific research,
- potential risks,
- the possibility for the participant to withdraw from it freely at any time without any consequences, possibly not to participate in it at all.

Ethics is often felt by researchers as unnecessary administration, hindering or even hindering research. The fact is that adherence to ethical research requirements places a line between what is ethically acceptable and what is no longer. In no case does ethics have the ambition to regulate research, nor does it restrict academic freedom, as guaranteed by the European Charter of Fundamental Rights in Art. 13. If the project addresses ethically sensitive issues, a detailed justification of the need and adequacy of the use of, for example, personal data or human subjects is necessary.

An important part of the strategy of this ethical approach to research is the absence of the influence of influence, leading to the subject to decide to participate arbitrarily in the survey. The rules that should guide the ethical approach to neuromarketing are:

- Nuremberg Code.
- Declaration of Helsinki.
- Convention on Human Rights and Biomedicine.

- UNESCO declaration.

In the process of setting up a strategy for an ethical approach to research, it is important to focus on the first phase - providing information about research. This phase can be described as a critical part of the whole strategic process. We must provide research participants - respondents with information in a comprehensible form, either in writing or orally, optimally both. It is very important that we formulate appropriate and easy-to-understand expressions and use information technology in an ideal state. A suitable form is the creation of an online questionnaire, which will provide us with fast and adequate feedback, available in real time and at any location.

Informed consent should be obtained if the research involves human subjects, human genetic material, human biological samples, or if it includes data on human subjects. Informed consent can be given to us by a person able to understand the research, its objectives and risks and to be able to make free decisions. Complications may arise with the provision of informed consent by persons in the case of:

- people serving prison sentences - prisoners,
- adolescents - small children,
- mentally retarded people,
- seriously injured people.

We can give informed consent individually with regard to local cultural customs in various forms - orally, in writing. It is important to maintain the autonomy of the respondents. In the case of community surveys, the presence of a community representative or lawyer representing a group of respondents is recommended.

The last phase in the strategy of ethical approach in neuromarketing research is the protection of data and privacy of respondents. This phase has a high priority and its importance is in principle from the preparation of the research proposal to its implementation. The responsibility for data protection lies with the organization where the neuromarketing research itself is carried out. The project proposal needs to describe in detail how to ensure data protection, privacy and confidentiality of personal data in their collection, archiving and processing so as not to misuse them, which could result in stigmatization, discrimination.

In particular, the Helsinki Declaration addressed the interests of research participants and can be applied appropriately in neuromarketing research. It contained elements such as: (Strand, Keizer, 2015)

- Medical research protects the life, health, privacy and dignity of human research participants / subjects over the interests of society
- Necessary measures must be taken to protect the interests of human subjects from harm
- The importance of the objectives must outweigh the inherent risks and burdens on participants - no abuse, no harm to human health
- Research must be clearly formulated and submitted for approval with a clear statement of ethical considerations
- Entities must volunteer and be informed of the implications of the research
- Scientists, research participants and all other parties have ethical obligations that must be clearly defined. This should ensure the accuracy of the results

published, all necessary information, sources of funding and any possible conflicts of interest, which must be clearly stated.

- Compensation for harm resulting from participation and justice for all.

Neuromarketing can, in certain cases, create a negative consumer attitude towards a company that uses such practices if the consumer is convinced that they are unethical. Given the discussions about the ethics of neuromarketing, it is quite understandable that brands actively using neuromarketing, especially in the US, prefer not to talk about it out of caution. On the other hand, it is clear that marketing researchers are rather mysterious due to concerns about the disclosure of sensitive information (Miláček, 2016). The question is whether the results obtained through neuromarketing research cannot be misused to induce excessive or irresponsible consumption.

5 Conclusion

The most important advantage of neuromarketing, which we identified in the analyzed texts compared to classical surveys, is mainly the independence of neuromarketing. We do not need the opinion of the respondent, we simply measure his emotional reaction and evaluate it completely independently. By analyzing the text, we found that it is important to protect the privacy of respondents. In the article we managed to identify several other benefits. One of them is simultaneity of data with the identification of emotional reactions processed in a second or millisecond, which will allow to demonstrate the triggering factor of this particular emotion. Another advantage is the possible diagnosis of respondents by doctors in case of health complications during the research.

From a consumer perspective, we have identified three basic pillars for building trust between researchers and respondents: transparency, security and accountability.

The main ethical issues surrounding neuromarketing include the invasion of privacy and consumer autonomy. Another ethical issue is the presence of doctors and academics conducting research for commercial purposes. Another problem is the concern about the exploitation of vulnerable groups, such as juveniles, the mentally retarded or the injured.

In this paper, we have identified four basic phases of an ethical approach strategy in neuromarketing research, starting with familiarity with the legislation in the research area, followed by finding and informing respondents about the objectives and risks of the research. This is followed by the phase of receiving informed consents from respondents, to whom they express consent to the research process and management and are aware of the objectives and risks of the research. The last phase of the ethical approach strategy in neuromarketing research is the protection of data and privacy of respondents, which takes place continuously from the beginning of the entire research process.

Furthermore, it is necessary to evaluate the burden-benefit ratio for participants, describe the possible potential consequences of research for human dignity, society, environment, culture, simply demonstrate the ability of the researcher to sensitively address the ethical dimensions of the research project. In the future, we recommend to

develop the individual phases of the strategy of ethical approach in neuromarketing and to supplement them with specific steps of the whole research process, so that the pillars of trust between respondents and researchers are preserved.

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Deciding on the location of the company

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Abstract. The aim of this paper is to focus on a theoretical view of the issue of business localization. Business localization is the subject of research in several disciplines of the global economy. Localization is one of the most important decision-making processes in a company. It is the process of choosing a location for a specific business plan. The characteristics of the company and its surroundings are also directly related to the business plan. Dynamic resp. the rapid development of information and communication technologies opens up new business opportunities.

Keywords: location, enterprise, business

JEL classification: O10, P42, P49

1 Introduction

The location of a company is the subject of research into several economic disciplines. Traditional economics examines the decision on geographical location in space mostly quantitatively, in terms of revenues, costs, missed opportunities and the like. It deals with site selection taking into account the various factors influencing this decision. Looking for the optimal solution. In the article we will state how the knowledge from the original theories in this direction gradually expanded to more modern theories. From the traditional solutions to the problem of locating the company in space, we will move in a separate chapter of the article to examine the issue from the perspective of the rapidly evolving behavioral economy. The aim of this separate chapter is not to bring an alternative view and different solutions, but to expand the knowledge of the issue with a new perspective and thus enable the problem to be grasped more comprehensively and explain some specifics of localization decisions that traditional theories do not sufficiently cover.

2 Origin and development of localization theories

Where to place a business? The answer to this question has been trying to find a huge number of economists since the beginning of economic science. Location theory has become an integral part of economic geography, spatial economics, and related sciences. We could use microeconomic theory based on the assumption that a company is trying to maximize its profits and individuals, ie agents of companies, are trying to maximize their benefits, on the basis of which they choose the optimal place for their business activities (Ross 1973). Although optimization of the position decision is a goal, due to the limited rationality of the decision, the optimal solution is rarely the result (Simon 1957).

In the following section, we present how theories of the position of business were formed with the expansion of economic theories and directions. The theories themselves do not determine where we have to do business, it is a decision problem for each particular company and its agents, but they expand the decision-maker's knowledge and lead to the right choice of methods that the company can apply to its specific situation.

The first impulse for the emergence of localization theories can be considered the emergence of spatial economics. Its foundations have already been laid by the economic theories of A. Smith, D. Ricard, K. Marx, N. Danilevsky, the theories of the representatives of the German School of Economics and the first researches in geopolitics. (Alpidovskaya and Popkova 2019) They aimed at the knowledge that economic activity is closely dependent on the chosen location and geographical location is a significant factor influencing the prosperity of the company.

Despite the undeniable merits of the above authors, Johann Heinrich von Thünen is considered to be the father of localization theories with his model of agricultural land use. We can consider the model as the first general theory of position. The fact that it is narrowed down to agricultural activities can be attributed to its origin before the spread of the industrial revolution in Germany. The theory works with a simplified "Cities" model. This is a model example of the use of economic modeling, which, by simplifying the conditions, provides space to explore the essence of:

"Imagine a very large city, in the middle of a fertile plain, which is not crossed by any navigable river or canal. Throughout the lowlands, the soil is cultivable and has the same fertility. Far from the city, the plain turns into uncultivated wilderness, which interrupts all communication between this state and the outside world. There are no other cities on the plain. The central city therefore has to supply the rural areas with all the products produced and in return receives raw materials from the surrounding country. The mines that provide the state with salt and metals are close to the central city, which, as it is the only one, we will simply call the "City" in the future. (Thünen 2011)

Competition between farmers will bring the price of rent and distribution costs into balance thanks to the invisible hand of the market, and so-called cultivation circles will

emerge, where crops with higher yields per unit are produced in a cultivation circle with higher rents closer to the city. Gradually, something like a circular shape map is created, which defines where each crop should be grown.

According to Samuelson (1983), Thünen's work not only created marginalism and a managerial economy, but also developed one of the first models of general equilibrium in terms of realistic econometric parameters. Specifically, Samuelson argues that Thünen's model contains all the elements of some well-known economic concepts:

1. Ricardo - Torrens' theory of comparative advantage.
2. Malthus - West - Ricardo theory of rent.
3. Heckscher - Ohlin and Stolper - Samuelson theory of pricing of factors and goods.
4. Input-output system authors: Marx - Dmitriev - Leontief - Sraffa.

Samuelson states that "*Thünen belongs to the Pantheon with Leon Walras, John Stuart Mill and Adam Smith. Thünen's work is like a magnificent building of general equilibrium, containing all the basic elements of modern competition theory.*" (Samuelson 1983)

Thünen (1826), Launhardt (1882) and Marshall (1886) were the first to emphasize the importance of locating a business. Their theories were tied to agricultural production. Their theories worked with variables such as distance from city or rent. Many theories from their research are also taken over by today's theories, which also work with various variables that affect the location of the company. Today we call these variables factors. Weber (1909) was the first to introduce this concept to economics. In the 20th century, localization theories from agricultural production began to focus on industrial production. The first theory, which also dealt with the location of services and administration, was presented by W. Christaller in 1933, directly following Thünen's research.

Most of the authors of the economic geography of the post-war period are based on Thünen's findings, which he expands, packs up or tries to replace part of his theory with his own research. In order to make the most optimal decision on the location of a particular business, it is appropriate for the decision-maker to know the important theories of economic geography, which explain the behavior of market entities. The authors looked at the issue of business location from different perspectives. If the decision-maker realizes that it is necessary to look at the problem of placement from different angles, combining optimal solutions from different perspectives, involving creative thinking and knowledge provided by us, he can make the decision to locate the business better than its competitors.

2.1 Current understanding of business location

The authors of geographical economics, presented in the first part, conditioned the emergence of newer theories of business location, introduced key concepts and explained the basics of simplified models. The vast majority of theories of localization of a company deal with the term factor and based on the analysis of the action of a number of factors, the company chooses the place where it will carry out its economic activities.

Real spatial systems function as complexes of elements and components, interconnected by spatial processes. Localization factors express the requirements for the characteristics of the territory from the entity that is interested in the location of its element, its investment in the territory. In this case, it is a specific demand for territorial elements, phenomena or properties. Localization factors therefore fundamentally influence our localization behavior and decision. (Maier and Todtling 1997) There are therefore a large number of factors that influence the choice of a specific place of business. It always depends on the specific decision-making situation which of these production factors the company will prefer. (Hudec et al. 2009)

Currie states that *"Factors that affect the location of economic activities vary. Businesses or commercial companies often consider the pros and cons and multiple locations before deciding where to build."* (Cambers and Currie 1999)

The price factor must be spatially differentiated. Only when both conditions are met will different conditions arise for the company in different locations and it must take this into account when making decisions. " (Belajová and Fáziková 2002)

Accordingly, the factors are specific to each company. Several authors have tried to establish a list of relevant factors. If we have a list of relevant factors for our company, from the point of view of business decision-making, the choice of a specific location is a common decision-making task ideally in conditions of certainty, but mostly uncertainty or risk, depending on the amount and quality of available information. For such a decision we can use any of the known methods of decision analysis such as Saaty AHP, pairwise comparison, nominal, ordinal and cardinal scales and others. The problem is not based on the available information to evaluate one of the methods of business decision-making a suitable location. The problem is to choose the right set of factors and assign them a weight. Due to the weight when making a decision, factors with a higher weight influence the final decision more than factors with a lower weight.

Some authors categorize factors into groups. The categorization of factors, in addition to simplifying the orientation in a large number of influences on the company, allows to assess the significance of factors in complex internally interconnected groups.

In the spatial and regional economy, localization factors are divided as follows (Belajová and Fáziková 2005):

Soil and land are immobile factor and space act strongly differentiating. It goes e.g. o land prices, land with a certain quality to their access, etc.

Natural resources are defined as predominantly displaceable and their occurrence in space can also be highly concentrated.

Capital is highly concentrated and its mobility depends on the species. Financial capital is highly mobile, but this cannot be said of in-kind capital. Once invested, it is immobile, as the cost of moving it is high.

The workforce is spatially highly differentiated in terms of availability, quality and price. Daily attendance is highly mobile, with population migration between regions being very limited.

Technical progress / innovation is defined as spatially differentiated, which means that information on new technology and forms is mobile, while its implementation depends on the demand of companies.

According to Maier and Tödting, an important criterion for classifying localization factors is the company's relationship with the environment. According to this criterion, localization factors are divided as follows: (Maier and Tödting 1997)

availability and access to inputs, e.g. natural resources, labor, availability of public services, etc. Not only the presence of localization factors is important, but also their quantity, price and quality,

access to relevant markets and customers on the output side,

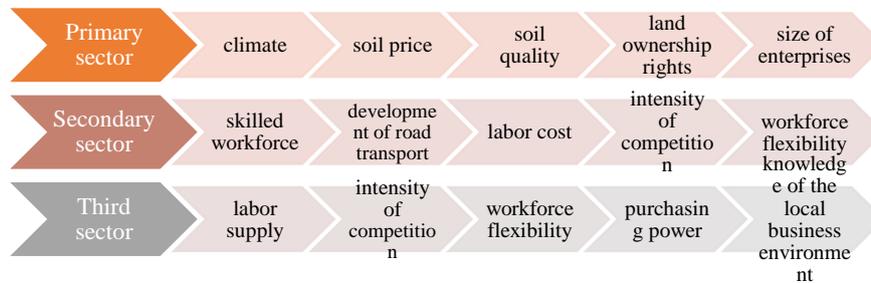
depends on market potential, transport costs, waste treatment options, information and contacts and the location of competitors,

factors active on the input and output side - these are technical and social infrastructure and agglomeration benefits.

The significance of business location factors in Slovakia was empirically investigated in the studies of M. Cifranič and Gubáňová and Hanáčková. (Cifranič 2016; Gubáňová and Hanáčková 2014) The M. Cifranič survey was a questionnaire survey of managers of 5 selected companies. The questions in the questionnaire were constructed in the form of open-ended questions. 24 localization factors were divided into 6 categories, namely work, market, land, infrastructure, environment and legal social and economic conditions. Managers of selected companies were asked to assess the significance of localization factors on the provided point scale from level 0 (no significance) to level 4 (main factor). The main determinants of the allocation of these companies were labor flexibility and related costs, the organization of the distribution network, the size of the land, local standards for the discharge of hazardous substances and the economic and social stability of the region. On the other hand, the least important factors were the supply of disabled workers, climatic conditions and the level of institutions and services to support regional development. (Cifranič 2016)

In the survey of Gubáňová and Hanáčková, the importance of factors from the point of view of individual sectors was examined (Figure 1). From the survey we can see how the importance of sectors changes depending on the sector in which companies operate. (Gubáňová and Hanáčková 2014)

This follows from the nature of individual sectors, the differences in the inputs they consume and the outputs produced by companies, the target markets where they trade, the demands on individual components of capital and the like.

Figure 1 - Significance of localization factors

Source: GUBÁŇOVÁ, Monika and Denisa HANÁČKOVÁ, 2014. *The importance of localization factors for the allocation of companies in space. 2014, vol. 6, no. 3, p. 9.*

3 Results of the work and discussion

Each business must choose its location. The decision on the position may be the result of a more or less formal procedure. There is a consensus among scientists that the decision to locate a company is important for the economic performance of the entity. At the same time, we can find in the literature that subjective factors (such as limited rationality) play a significant role in site selection. (Jones and Woods 2002) R. Domański outlines that decision-makers usually have limited knowledge and information and in many cases the management of a company does not behave like a homo economicus. Sometimes it has limited resp. biased information and its decisions are thus based on incomplete information still assessed in a subjective way. If the situation is complicated, the decision-maker must simplify it with intuitive rules. It does not try to achieve an optimal result, but a satisfactory one. (Domanski 2004)

According to the classical, neoclassical understanding of localization theories, the decision made by the decision-making body is the optimal choice, while heterodox approaches, such as behavioral economics, argue that an optimal decision is impossible.

The mainstream of economic theorists assumes that decision-makers are homo economicus, a person who is perfectly informed, able, and willing to make complex calculations without behavior prone to psychological prejudices. Behavioral economics takes into account a number of assumptions about human nature: limited (imperfect) knowledge, limited ability to process information, and a tendency to look for the first satisfactory result rather than optimal. In practice, this means that usually the company chooses the first place that meets its minimum criteria, the so-called level of aspiration and will not even explore other alternatives. Simon pointed out that people can use the so-called heuristics, which represent a simplification of the decision in a complicated situation, which heuristics are not specified. (Simon and Newell 1958)

This gap was filled by D. Kahneman and A. Tversky (Tversky and Kahneman 1974), who formulated three famous heuristics: accessibility, representativeness, and anchoring with adaptation. Accessibility in psychology is the ease with which a certain idea can be obtained. For example, people overestimate the seriousness of dramatic

mediated events. If they see, for example, a tornado, they are much more likely to die than death in a home accident falling down the stairs. Objectively, the probability of death when falling down stairs is incomparably higher. We can assume a similar "use" of heuristics when deciding on the location of the company. For example, it may assess the possibility of the arrival of cheap labor on the basis of mediated dramatic information on migration, and in fact this phenomenon may have a much smaller impact on labor costs than non-dramatized media lifelong learning programs in the media.

He later used the theory of limited rationality in his localization model A. The behavioral matrix he formulated linked the availability of information, the investor's ability to process information and the "profitability" of the chosen place of business. The general rule is that the more information (or ability to process information) a decision maker has, the more lucrative a person chooses, *caeteris paribus*.

Due to the breadth of the object of research, which in our paper represents the theoretical framework of decision-making on the location of the company, it was not possible to present the topic completely exhaustively. The literature offers a myriad of different approaches to the problem in the nearly 3rd century since the emergence of early theories. Through a paper with domestic and foreign literature, we gained relevant knowledge that led to a clarification of the current situation. The added value of the work lies in the broadening of the perspective, revealing to the reader a view unknown to him of a familiar issue.

The paper can serve as a basis for further professional discussion on the topic of business localization. Behavioral economics is still a young scientific discipline and offers a wide space for the application of empirical research methods and the acquisition of new knowledge usable in managerial practice. We wanted to point out the fact that the topic of business localization, which almost privately belongs to the study of traditional, classical and neoclassical economic schools, can use the knowledge of behavioral economics and descriptive approaches to decision-making to expand their knowledge.

We think that research, which subsided slightly in the 1980s, in the context of today, when the economics of "soft" factors, psychology or neuroscience come to the fore, will be renewed in the foreseeable future and will be a source of new knowledge not only in business localization but economy as such. This is evidenced by several studies carried out in recent decades, the authors of which have earned the recognition of the professional public and the world, and whose work has been awarded, among other prestigious awards, the Nobel Prize.

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Attitudes of a selected group of consumers to car electrification

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Abstract. "In order to achieve the EU's goal of climate neutrality by 2050, in line with the objectives of the Paris Agreement, the EU must increase its ambitions for the coming decade and update its climate and energy policy framework. To this end, the European Council endorses the EU's binding 2030 domestic reduction of greenhouse gas emissions by at least 55% compared to 1990. "These are the conclusions of the European Council from December 2020. As part of EU action, it calls on car makers to increase the share of electric cars by reducing quotas for maximum CO₂ emissions. Our article deals with the causes and factors that prompted these steps and examines the attitude of the selected group to these steps.

Keywords: Electromobility, European Union, Electrification, Students, Attitude

JEL classification: M38, O14, O18

1 Introduction

"In order to achieve the European Union's climate neutrality target by 2050, in line with the objectives of the Paris Agreement, the European Union must increase its ambitions for the coming decade and update its climate and energy policy framework. To this end, the European Council endorses the European Union's binding a net domestic reduction in greenhouse gas emissions of at least 55% by 2030 compared to 1990. "These are the conclusions of the December 2020 European Council. In this paper we characterize these goals and their impact on the electrification of cars and then, based on a quantitative survey, we examine the attitudes of a selected group of consumers to the electrification of cars.

2 Methodology

The main aim of the article is to find out how a selected group of consumers perceive the actions of the European Union in the fight against climate change and whether or how it would affect their behavior when deciding to buy a car.

To meet the main goal, we will be helped by partial theoretical goals, in particular the analysis of factors influencing the decisions of the European Union in this area and the analysis of the conclusions of the European Council of December 2020 and May 2021. In addition, we characterize the electrification strategies of individual car makers.

We obtained primary sources using the method of marketing quantitative research by standardized inquiry through a structured questionnaire. The selected sample was a group of potential car users, students of the fourth year of the Faculty of Business of the University of Economics in Bratislava. The inquiry took place on 19.4.2021 on a sample of 114 respondents. From the total number of respondents, we obtained 63 answers. Before asking a selected group of consumers - potential car users - on the topic of car electrification, these respondents were thoroughly acquainted with the steps of the European Union as well as individual car producers for the purpose of forming a relevant opinion to the issue.

To meet our objectives, we used the following research methods:

- comparison and analysis of the source of publications on the chosen topic and synthesis of the identified approaches and theories to understand the interrelationships of the issue,
- collection, critical analysis, and synthesis of collected data from secondary sources,
- a method of scientific abstraction to identify and disclose irrelevant information,
- a method of deduction aimed at formulating the main areas of research,
- the method of marketing quantitative survey by standardized inquiry through a structured questionnaire,
- graphical methods aimed at clarifying the information obtained.

3 Results and Discussion

3.1 Literature review

According to survey conveyed in London on 1263 respondents, who had purchased Hybrid electric vehicle Toyota Prius in the last 24 Months concludes based on binary factor analysis that UK financial incentives and transport policies play important role in decision making for switching to electric vehicle. Moreover, this study also pointed out that factors influencing the rise of electric vehicles purchase are besides governmental policies for example environmental benefits such as low emissions, comfort of driving and economic benefits. [1]

Based on structural equation modelling on survey of 167 consumers participating in electric vehicles test driving are the factors slowing the electric vehicles rise the expensive purchase cost, long recharge duration, insufficient charging infrastructure and short travel range. They also think that to determine the effectiveness of electric

vehicles as climate-friendly it is important to measure the renewable energy share of electricity generation. [2]

3.2 European Council steps towards achieving net zero greenhouse gas emissions

The European Union has committed itself to achieving a net domestic reduction in greenhouse gas emissions of at least 55% by 2030 compared to 1990. They made this commitment at the European Council of 10-11 December 2020.[1] Based on this commitment, the Council adopted a general approach on 17 December 2020, followed by the launch of a series of dialogue meetings between the Council and Parliament aimed at reaching a final agreement.[3]

The existential threat posed by climate change requires greater ambition as well as stronger climate action by the Union and the Member States. The Union is determined to further increase its efforts to combat climate change and to implement the 2015 Paris Agreement on Climate Change, which was the result of the 21st Conference of the Parties to the United Nations Framework Convention on Climate Change, guided by its principles and based on the best available scientific knowledge in the context of the long-term goal of the Paris Agreement to reduce temperature. [4]

In its Communication of 11 December 2019 entitled The European Green Deal, the Commission set out a new growth strategy to transform the Union into a fair and prosperous society with a modern and competitive resource-efficient economy that will achieve net zero greenhouse gas emissions by 2050. It also aims to protect, preserve, and enhance the Union's natural capital and to protect the health and well-being of citizens from environmental risks and impacts. [5]

Actions preventing climate change should be an opportunity for all sectors of the economy in the European Union to help ensure industry leadership in global innovation. Led by Union regulators and the efforts made by industry, economic growth can be decoupled from greenhouse gas emissions. For example, while the economy grew by 60% between 1990 and 2019, greenhouse gas emissions in the European Union fell by 24% over the same period. Without prejudice to binding legislation and other initiatives taken at European Union level, all economic sectors - including energy, industry, transport, heating and cooling of buildings, agriculture, waste management and land use and forestry, and whether they are covered by the European Union Emissions Trading Scheme - should play a role in achieving climate neutrality in the European Union by 2050.

In pursuit of the European Union's new climate goal of 2030, the Commission has announced a revision of the relevant climate and energy legislation, which will be adopted in a package covering renewable energy, energy efficiency, land use, energy taxation, efficient CO₂ emission standards for commercial vehicles, effort sharing and the emissions trading scheme. The Commission intends to assess the impact of the introduction of other European measures that could complement existing measures, such as market measures, which include a strong solidarity mechanism.

As citizens and communities play an important role in promoting the transition to climate neutrality, strong public and social engagement in climate action at all levels,

including at national, regional, and local levels, should be encouraged, and facilitated in an accessible way. The European Commission should therefore work with all sections of society, including stakeholders representing different sectors of the economy to enable and empower them towards a climate-neutral society.

European Council conclusions with impact on electromobility

Greenhouse gas emissions and removals regulated by Union legislation will be exported within the Union by 2050 at the latest, reducing emissions to zero by that date, after which the Union will strive to achieve negative emissions.

The relevant institutions of the European Union and the Member States shall take the necessary measures at European Union-wide or national level to enable the objective of climate neutrality to be achieved collectively, considering the importance of promoting justice and solidarity between Member States and cost-effectiveness in achieving those objectives.

Regarding the 2030 target, negotiators agreed on the need to prioritize emission reductions over their elimination. To ensure that sufficient efforts are made to reduce emissions by 2030, they have introduced a limit of 225 MtCO₂, which corresponds to the contribution of removal to the target.

The Commission will use all relevant instruments, including the European Climate Pact, to involve citizens, social partners, and stakeholders to promote dialogue and the dissemination of scientific information on climate change and its social and gender aspects.

The Commission is working with the economic sectors of the European Union, which will decide to draw up indicative voluntary plans to achieve the European Union's goal of climate neutrality by 2050. The European Commission is monitoring the development of these plans. Its involvement includes facilitating dialogue at European Union level and sharing best practices between relevant stakeholders.

As stated in the Communication on the European Green Agreement, on 9 December 2020, the European Commission adopted a Communication on a strategy for sustainable and intelligent mobility - kick-starting the European transport of the future. The strategy sets out a roadmap for a sustainable and intelligent future for European transport, with an action plan to achieve a 90% reduction in emissions from the transport sector by 2050.[6]

3.3 Response of car producers to the European Union's strategies for achieving greenhouse gas reduction targets

Based on the European Union's information on the intention to reduce greenhouse gas emissions in every sector of the economy, car manufacturers have had to adapt their approach and fleet to this goal. Many car producers publicly announce their intention to achieve greenhouse gas reduction targets in various ways.

Toyota Motor Corp.

Toyota, one of the pioneers in electrification is lagging far behind its competitors since then, announced a strategy for electric vehicles, which will result in 15 new battery-powered electric vehicles introduced by 2025.

Toyota has announced that by 2025, it will launch 70 new models, including battery, hydrogen, and gas electric hybrids, which will offer customers a variety of "diverse options". The company, which is the largest car producer in the world, will manufacture these vehicles using a flexible platform, which it has developed in cooperation with the Japanese car producer Subaru.

Until now, Toyota has resisted that electric vehicles are considered the future of the automotive industry, even though it has been a pioneer in battery-powered transportation. In its announcement, Toyota described its success in the hybrid market by selling 17 million "electrified vehicles" since the launch of the Prius in 1997.[7]

Volkswagen AG

Volkswagen wants electric vehicles to make up the majority of its main brand's European sales by 2030. It expects fully electric vehicles to account for more than 70% of total European vehicle market sales by 2030, compared to its previous target of 35%.

Facing the challenges of Apple, Google and Amazon, Volkswagen also plans to offer autonomous vehicles and wants to develop its own operating systems - the heart of future electric cars.

Volkswagen has set aside around € 16 billion to invest in future trends in electromobility, hybridization and digitization by 2025. [8]

Daimler AG

The Daimler Group and its iconic Mercedes-Benz brand are global leaders in luxury cars made in Germany. The company is a classic driver of automotive innovation but has been slow to start making serious use of electric propulsion. Daimler, frightened by the success of his former junior partner Tesla, finally announced a dramatic shift towards a carbon-neutral future in transport and set ambitious new sustainability goals. The company has not yet decided to stop the development of internal combustion engines but plans to make its cars fully CO2 neutral by 2039.

In 2020, Mercedes-Benz tripled its global sales of plug-in hybrids and pure electric vehicles to more than 160,000 units, increasing the share of electric vehicles to more than 7% from 2% in 2019." The year 2021 represents primarily an acceleration of electrification in Mercedes-Benz Cars.

At the time of the introduction of the EQC, Daimler also committed to a more general climate initiative called "Ambition2039". Shortly before taking up his new role as CEO, Källenius promised to ensure that the entire Mercedes-Benz Cars fleet was carbon neutral by 2039. The company plans to produce CO2-neutral production in its European plants using renewable energy by 2022. By 2025, up to 25% of cars sold should be exclusively electric - but with the proviso that this will "depend on framework conditions". By 2030, Daimler aims to ensure that pure electric and plug-in hybrids

account for more than half of car sales, while reducing the number of internal combustion engine models by 70%. [9]

Ford Motor Co.

In 2021, Ford announced a doubling of investment in electric vehicles to \$ 22 billion (€ 18 billion) by 2025 and an increase in total investment in automated control to \$ 7 billion (€ 5.75 billion) from \$ 4 billion (€ 3.29 billion).

Ford began delivering the Mustang Mach-E, its first purely electric vehicle, in late December 2020 and plans to increase deliveries in early February 2021. Mach-E for North America and Europe is manufactured in Mexico, but the car producer recently announced that in the spring of 2021 it will expand production for the Chinese market from its assembly plant in Changan.

As part of an expanded commitment, Ford says electric vehicles will be the basis for the Lincoln premium brand.[10]

Honda Motor Co.

Honda has set its electrification strategy for the next two decades. The goal is the year 2040, in which all its offered vehicles will be electric or otherwise emission-free. Honda's transition to electric vehicles will be gradual and will not neglect hydrogen fuel cell vehicles - a technology that is provoking further debate about its importance.

The car producer plans to take various steps in various markets to have 40% of its offer in North America on battery or hydrogen vehicles by 2030, five years later this figure is expected to climb to 80%. By 2040, Honda wants 100% of its vehicles to be battery or hydrogen powered. Looking to the immediate future, the carmaker says it is working with General Motors to develop two large models of electric vehicles based on General Motors' Ultium powertrain and batteries, both of which should be available by 2024, one under the Acura brand and one under the Honda brand.[11]

Volvo Cars

Volvo Cars is committed to becoming a leader in the fast-growing premium electric car market and plans to become a fully electric company by 2030. Until then, the company intends to sell only fully electric cars and phase out any car from its global portfolio with internal combustion engines, including hybrids.

The company's transition to a fully electric car manufacturer is part of its ambitious climate plan, which aims to reduce the carbon footprint of a car's life cycle through concrete measures. Its decision is also based on the expectation that legislation, as well as the rapid expansion of available high-quality charging infrastructure, will accelerate consumer acceptance of fully electric cars.

The ambition to 2030 represents an acceleration of Volvo Cars' electrification strategy, driven by the strong demand for its electrified cars in recent years and the company belief that the market for internal combustion engines is shrinking. [12]

3.4 Attitudes of a selected group of consumers to car electrification

Based on a survey we conducted on a selected group of potential car users, we came to the following results.

Figure 1 shows the opinion of a selected group of consumers on the magnitude of the impact of electrification on climate change in terms of reducing greenhouse gas emissions from cars affecting the climate through electrification. The rating was on a scale of 1 to 5, with 1 meaning no and 5 a very high positive impact on climate change. We see that more than 57% of potential car users thought that the positive impact of electrification on climate change would be high and 32% thought that the positive impact would be medium. So we see that up to 89% of students think that electrifying vehicles will have a positive impact on climate change.

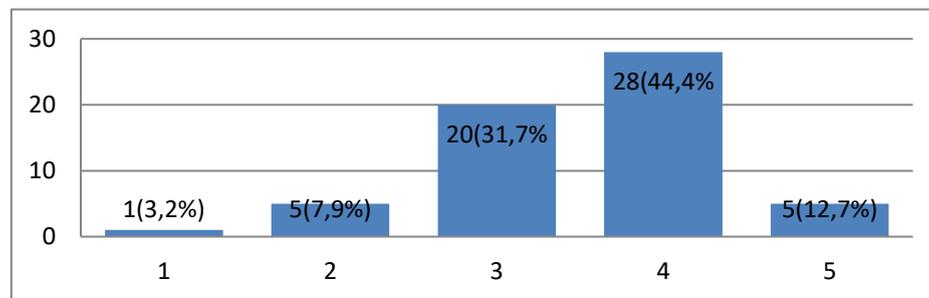


Fig. 9. How big impact do you think the electrification of car fleets will have on climate change?

In Figure 2 we see the opinion on the same issue among respondents whose household does not own any car. In this group, we see that everyone thinks that electrification will have at least some positive impact on climate change.

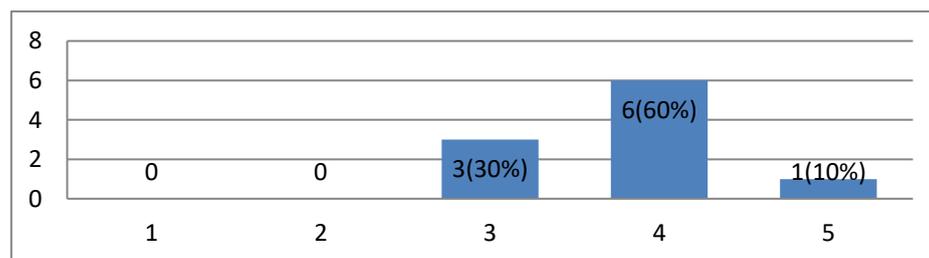


Fig. 2. How big impact do you think the electrification of car fleets will have on climate change? (For respondents whose household does not own a car)

In Figure 3 we see the opinion of a selected group of consumers whether the benefits of electrification, i.e. especially the reduction of greenhouse gas emissions in order to reverse climate change outweigh the possible disadvantages of electrification, such as

increasing the total cost of purchasing an electric vehicle or its maintenance. Two-thirds of respondents think that the benefits outweigh the possible disadvantages.

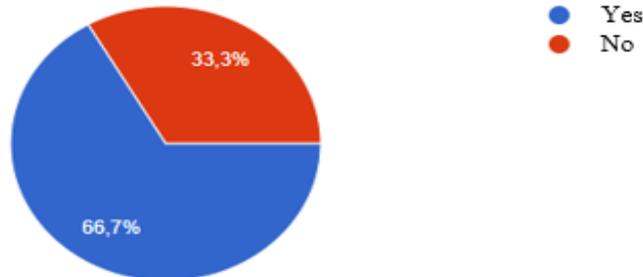


Fig. 3. In your opinion, are the benefits (reduction of emissions) of electrification adequate to its possible disadvantages (increasing the total costs of procurement and maintenance)?

Figure 4 shows whether, in the opinion of a selected group of consumers, the interest in buying electric cars will increase, decrease or remain the same based on information about electrification. The answer that interest will increase is copying the trend of previous charts and was chosen by about two-thirds of respondents. About 29% of respondents think that interest will not change and only about 5% think that interest will decrease. Unsurprisingly, these consumers also think that the positive impact of electrification on the environment will be low.



Fig. 4. In your opinion, how will electrification, or rather consumer awareness of electrification, affect the approach of Slovak consumers to buying cars?

4 Conclusion

Based on our article, we see that the European Union is working to reduce greenhouse gas emissions in all sectors. One of the main sectors of the economy affected by these plans is undoubtedly car manufacturers. Based on the analysis, we found that all larger carmakers have set electrification strategies for the coming period, some in the shorter, others in the longer term.

After conducting a quantitative survey of a selected group of respondents familiar with electrification at the European Union level and at the level of automobiles, we see that they mostly hold a positive view of the effects of electrification on access to electromobility at the level of Slovak consumers and personally. The selected group of respondents also mostly thought that the impact of electrification on climate change would be positive.

Unfortunately, we were unable to compare our research results to other research done in the past as the survey structure was very unique and linked to the latest European Council conclusions.

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How to increase Consumer acceptance of the transition to Circular Economy

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Abstract. The transition to the circular economy (CE) is a major theme for stakeholders from business and politics, but if the transition is supposed to be successful, we must shift our attention to consumers and their behavior as well. We know from literature that consumers don't have enough information about CE and therefore we have to find way how to increase their knowledge. The lack of consumer awareness and acceptance has been mentioned as an important barrier for the development of a CE. Manufacturers will arrange their products to services and will have to convince consumers to switch from consuming products to consuming their services. The products will remain the property of the manufacturers and customers will buy the services they provide. The business model turns around. Are consumers prepared to this change?

Key words: Circular Economy, Consumer, Transition

JEL Classification: M31, Q56

1 Introduction

The transition to the circular economy is a socio-political-economic phenomenon that deserves deeper scientific examination. It is a change that we can compare to the industrial revolution by its impact and scope, a change that society and the economy must adapt. The transition to the circular economy is a major challenge for entrepreneurs - companies – producers and we will show that for consumers as well. The transition to a circular economy is a tool to deal with climate change, which will be the most important issue of the next decade.

2 Methods

The basic methods of scientific heuristics such as analysis, synthesis, induction, deduction, description, comparison are used in the paper.

Public survey made by online united questionnaire, by method CAWI - Computer Assisted Web Interviewing. Method CAWI means that respondents are recruiting online and answers online questionnaire. This methodology allowed display picture, videos, and tables. CAWI combine advantages of qualitative and quantitative survey.

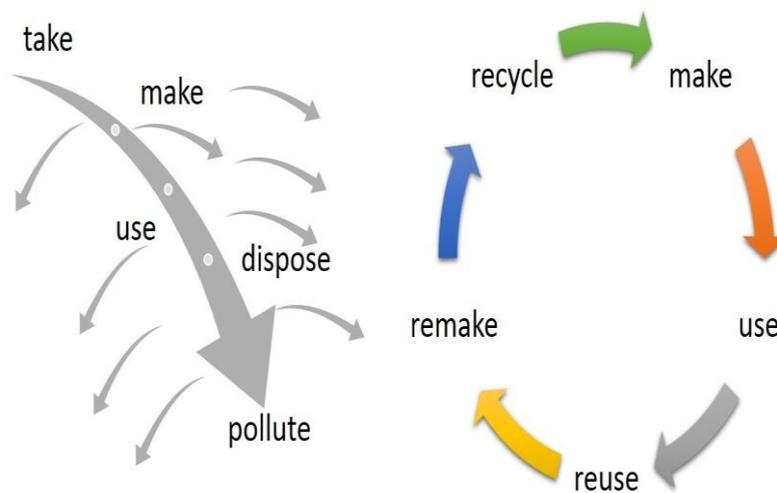
Data analysis was realized on a sample of 511 respondents. Respondents for the survey were select from Slovak National Panel. Target group was internet population 15+.

The survey was made by the company Nielsen/ Admosphere.

3 Fundamentals of the Circular Economy

CE has the potential to understand and implement radically new patterns and help society reach increased sustainability and wellbeing at low or no material, energy and environmental costs. (Ghisellini, 2015) CE could be a solution to the need for reducing the environmental impacts of business-as-usual economic systems. (Ghisellini, 2015)

Pic. 1 Linear Economy vs. Circular Economy



CC 3.0 Catherine Weetman 2016

The theme of the Circular Economy is very actual and young as well. It means that the amount of the scholarly literature is limited. More than 100 articles were published on the topic in 2016, compared to only about 30 articles in 2014 in (Kirchher).

The concept of the Circular Economy has been gaining momentum since the late 1970s (EMF, 2013b). Several authors, like Andersen (2007), Ghisellini et al. (2016), and Su et al. (2013) attribute the introduction of the concept to Pearce and Turner (1989).

The concept of Circular Economy is based on several economic scholars. The main base is the theory “cradle to cradle“ from Michael Braungart a Bill McDonough. Second main source is the theory of Waltera Stahela Looped and Performance Economy and the theory of Industrial Ecology (Preston 2012).

The most renowned definition has been framed by the Ellen MacArthur Foundation, introducing the Circular Economy as “an industrial economy that is restorative or regenerative by intention and design“ (EMF, 2013b). Geng a Doberstein (2008: 231) describes CE as the realization of closed loop material flow in the whole economic system.

Very appropriate definition of Circular Economy is when CE seems like a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintains, repair, reuse, remanufacturing, refurbishing, and recycling. (Geissdoerfer). Most of the scientist analyzes is focus on the transition to CE in China and Europe.

4 Discussion

Progress in the transition to CE depends on the acceptance of this concept by the consumers because CE push consumer to change their habits and goes beyond the individual purchase of new products to new forms of consumption. Consumers change roles in a CE from buyer and user to purchasers, maintainers, repairers, sellers, sharers, collaborators, and waste discarders.

The lack of consumer awareness and acceptance has been mentioned as an important barrier for the development of a CE therefore we have to increase their awareness about CE. We can use consumers fears about environment and climate change as far as consumers inclination for innovations for increasing interest and knowledge about circular economy.

Specifically, consumers have to change their traditional roles as individuals who buy and use goods (e.g., reusing, repairing, refurbishing, remanufacturing, recycling) to include new consumption forms, such as peer-to-peer transactions, sharing, borrowing and leasing.

Manufacturers will change their products to services and will have to convince consumers to switch from consuming products to consuming their services. The products will remain the property of the manufacturers and customers will buy the services they provide. The business model turns around.

Manufacturers will need to design and manufacture products to return to their customers after they have done their job so that they can be used by others, or repaired

or recycled, and this will require a new look for products, their usage and handling with them.

Consumer awareness and interest and involvement in the CE is low (Siet J. Sijtsema, 2019) and therefore we need increase their knowledge and interests. We can use several emotional associations and feelings which were mentioned in this study. Within the context of this study, at the beginning and the end of the session, consumers expressed concerns about the critical situation of planet Earth. They raised this issue in phrases such as, "If we continue like this, we will not make it."

4.1 Key factors for incorporation Consumer to transition to CE

Acceptance of CE

Circular Economy and the concept of circularity is usually analyzed from the production and business point of view but for development of the CE is necessary to incorporate consumers to this transition. We have to increase consumers awareness and thru the awareness also the acceptance.

Some companies participate in the circular economy through the production of recycled products however, these initiatives will only be successful if consumers are willing to accept these circular products with some compromises or thru innovations there will be no differences between products made from primary raw material and recycled material. Therefore, consumers' acceptance of recycled products is a key factor for ensuring success of circular business models.

Most studies in which consumers have been questioned about their knowledge and acceptance of the CE have focused on specific solutions and studied consumer acceptance of specific types of products or functions, especially in relation to fashion and phones (e.g., explored the factors that influence consumer acceptance of refurbished mobile phones; they identified consumers' lack of awareness, a misunderstanding of what refurbishment actually entails, and a negative trade-off between perceived risks and benefits). A review of these studies showed that the acceptance of a CE depends on personal characteristics (e.g., materialism), product and service offerings (e.g., product quality), knowledge and understanding, experience and social aspects (e.g., privacy), perceptions of risks and uncertainty, benefits, and other psychological factors (e.g., norms). (Ghisellini, 2015).

Environmental concern

Environmental concern (EC) plays an important role in the influencing of consumer habits and influencing purchasing choices as well (Newton et al., 2015; Trivedi, Patel, & Acharya, 2018; Yarimoglu & Binboga, 2019). EC can be understood as the individuals' answerer to pollution and the degradation of natural resources (Trivedi et al., 2018). This holds a important place in the theoretical frameworks used for predicting green purchasing behavior. For instance, EC is one of the beliefs that

constitute attitude in the theory of planned behavior framework (Cerri, Testa, & Rizzi, 2018) and personal norm in the value-belief-norm theory (Stern, Dietz, Abel, Guagnano, & Kalof, 1999).

Purchasing behavior

Purchasing behavior is one of the most important behavioral manifestations of an individual's commitment to the environment.

We can use consumers environmental concerns to change their purchasing behavior. We need to increase knowledge of the consumers which purchasing behavior is in favor with the transition to CE and thru this transition we can satisfy their environmental concerns.

Stern (2000) identified four environmentally significant behaviors, which are influenced by the same set of causal variables: environmental activism, non-activist public-sphere behaviors, private sphere environmentalism (which also encompasses green purchasing behaviors), and behaviors affecting organizational decisions.

Innovations

The concept of the circular economy is increasingly linked with the concept of innovation (Bocken, De Pauw, Bakker, & van der Grinten, 2016). Many companies are implementing innovative solutions for recovering waste and producing a new product or packaging through recycling or upcycling (Gusmerotti, Testa, Corsini, Pretner, & Iraldo, 2019).

Investigating the drivers of circular purchasing behaviors therefore cannot exclude consumer innovativeness (CI), that is the personal “predisposition to buy new and different brands and products rather than remaining with previous choices and consumption patterns” (Steenkamp, Ter Hofstede, & Wedel, 1999).

There are at least two types of CI: (a) “general innate innovativeness,” i.e. a generalized predisposition to the adoption of innovations applicable across different product categories, and (b) “domain-specific innovativeness,” i.e. the predisposition to adopt innovative products in a specific product category (Kuswati, 2018; Roehrich, 2004).

Slovak consumers are prepared to change their consume behavior to protect climate change.

We used the theoretical basis mentioned in the paper to find if Slovak consumers have equal environmental concerns and if they are prepared to change their consume behavior to protect climate change and if we can use these concerns to push transition to circular economy.

In the cooperation with the company ASEKOL SK, which is Producer Responsibility Organization (PRO) for WEEE, packaging and battery and accumulators, we made

opinion research. We asked people about their environmental habits, separate collection of waste, littering and concerns connected with climate change.

The result from the survey is that consumers in Slovakia are prepared to change their consume behavior because they are afraid about climate change. Opinion research witch we made in September 2021.

The most significant question was: Are you prepare to change your consumer behavior in favor of climate protection?

The results of the opinion research were that most of the consumers are prepared to change their consumers behavior. This result was made in all Age groups as far as in all Education groups.

Are you preparing to change your consumer behavior in favor of climate protection?

		Yes	I don't know I need more information.	No	I am not interested	No I am not, I am not interested
<i>Summary</i>		76,8%	15,7%	4,6%	2,8%	7,5%
<i>Sex</i>	Man	76,0%	13,4%	6,7%	3,8%	10,5%
	Woman	77,6%	17,9%	2,7%	1,9%	4,6%
<i>Age</i>	15-24 years	76,3%	14,5%	7,8%	1,3%	9,1%
	25-34 years	76,9%	18,2%	4,0%	,9%	4,9%
	35-44 years	76,1%	16,0%	4,7%	3,2%	7,9%
	45-54 years	71,4%	16,3%	5,1%	7,3%	12,4%
	55 and more	82,4%	13,3%	2,6%	1,8%	4,4%
<i>Education</i>	Elementary and Second education without graduation.	70,4%	21,3%	4,8%	3,5%	8,2%
	Secondary with graduation.	76,7%	14,9%	5,6%	2,8%	8,5%
	University	84,7%	10,1%	3,0%	2,1%	5,1%
<i>Size of residents</i>	Village	73,8%	19,7%	5,3%	1,3%	6,5%
	Small and middle town	78,1%	13,0%	4,9%	4,0%	8,9%
	City	82,9%	11,0%	1,5%	4,5%	6,1%
<i>Region</i>	West Slovakia	78,8%	15,5%	3,3%	2,4%	5,7%
	Center Slovakia	72,7%	21,8%	3,9%	1,6%	5,5%
	East Slovakia	76,9%	10,9%	7,5%	4,6%	12,2%

Research was made in August 2021 by Nielsen/ Admosphere, for company ASEKOL SK. Methods online questionnaire, CAWI, respondents were select from Slovak National Panel.

5 Results and Conclusion

If we want to increase participation and acceptance of the transition to CE from consumers, we have to increase communication. We have to increase consumers knowledge about CE.

We have to link CE with other environmental issues. We have to sell CE as a part of solution of the climate change problem and as a tool how to reach carbon neutrality earlier and in sustainable way.

As was mentioned, consumers have been participating on the transformation to CE but they don't know that this service or product is a part of CE. We have to increase knowledge about what is CE and what is part of the CE.

Consumers are prepared to participate on the transition to CE because they love innovations, and they are afraid about environmental issues. Products and services which are part of the transition are not always sell as a part of the CE.

We have to communicate to the customers that CE is not still separate collection of waste or recycling, but they have to change their purchasing behavior.

We have to increase understanding of consumers' preferences, which would help in creating CE business models that are attractive in the eyes of consumers.

We propose three significant factors that are of interest to consumers regarding the services provided within the circular economy: ease of use, decreased environmental impact, and reduced cost.

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Analysis of job security and financial stability of households during COVID-19 in Slovakia and Europe

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Abstract. The presented paper provides analysis of job security and financial stability of households during COVID-19 in Slovakia and Europe. By analysing more than 135 000 answers from respondents across Europe we compare Slovakian jobs and financial situation with situation in other 26 EU countries during different phases of COVID-19 pandemic. Based on the data from questionnaire e-study named Living, working and COVID-19, we compare changes in EU citizens' perceptions of job security and financial stability during „first lockdown”, „reopening” and “year after” period of COVID-19's European outbreak. The results showed that most of citizens in most of EU countries though that it was unlikely or very unlikely that they lose their job in the next three months. These results were consistent during all three examined periods.

Keywords: COVID-19, Financial stability, Job security, Europe

JEL classification: J 81, E24

1 Introduction

The COVID-19 pandemic has triggered a public health crisis and government responses have triggered an employment crisis. The global exclusion, which limited the spread of the virus, also meant the necessary shutdown of much of the economy. (Ghose, 2020) Since the World Health Organization declared COVID-19 a pandemic on March 11, 2020, working life has changed drastically. As the government took steps to support the spread of COVID-19, many jobs had to be lost while some companies relocated as much work as possible online. (Qian-Fuller, 2020) The COVID-19 crisis could further increase long-term unemployment. The pandemic and other restrictions have brought about a sharp decline in activity and increased unemployment, especially for low-skilled workers who work from home. Otherwise, we expect the unemployment rate in Europe to rise from 6.3 percent in 2019 to 9 percent in 2020, at the same time through a comprehensive support program from the government. (European Commission, 2020)

There is an urgent need to find a solution to the economic impact of unemployment, which can be significant and widespread. Less employment means lower incomes for people, which in turn slows down demand. Due to lower demand for goods and services, the company will have lower revenues. The government's financial burden varies considerably because, in addition, employment taxes and demand will fall as the cost of the social system increases, which may lead to higher taxes. (Chinn, et al., 2020) Equally urgent is the need to find a solution because of the social consequences of unemployment, which are difficult to quantify but can also be significant. Increasing crime and social unrest are also potential consequences of rising unemployment. (Entorf - Sieger, 2014) How bad will be the economic impact of the current crisis will depend on two factors, i.e. from good human health and government decisions to alleviate pandemic restrictions. (Chinn et al., 2020)

2 Methodology and data

The aim of the research presented in this article is to characterize the Slovakian working environment in comparison with other EU countries during the COVID-19 pandemic. We will focus on job security and financial stability of Slovakian citizens. Based on questionnaire studies which include more 135 000 answers from respondents across Europe we compare Slovakian job and financial situation with situation in other 26 EU countries during different phases of COVID-19 pandemic. The research in this paper is based on questionnaire e-study named Living, working and COVID-19 which was conducted during three different periods of COVID-19's European outbreak. For the purpose of the research, we named the periods: 1. First lockdown, 2. Reopening and 3. Year after. The first round of data were collected during the first lockdowns period from April 9, 2020 to April 30, 2020 and contained 63,354 completely answered questionnaires. The Reopening period were realized "when economies and societies were gradually reopening" from 22 June 2020 to 27 July 2020 (Living, working and COVID-19 data, 2021) and included 24,123 fully answered online questionnaires collected within the EU countries. The Year after period of data collection was conducted almost year since first Europe's COVID-19 outbreak, during the time when countries were implementing different levels of measures to reduce spreading of new variants of COVID-19 virus. The round included 46,800 online questionnaires collected from 15 February 2021 to 30 March 2021 within the EU. The target group of the online survey was in the 18+ age category. The research sample covered all EU-27 countries. The research data are available at: <https://data.europa.eu/data/datasets/living-working-and-covid-19-data?locale=en>. Although study covers 7 different areas, for the purpose of the research presented in this paper we focused only on areas named Working during COVID-19 and Financial situation and security during COVID-19. From these segments we extracted four questions which we used for our research. The overview of questions together with answers used for the research is presented in the Table 1 below.

Table 1. Overview of questions using for research

Question:	Possible answers	Answers used in the analysis	R.
Using this scale, how likely or unlikely do you think it is that you might lose your job in the next 3 months?	5. Very likely; 4. Rather likely; 3. Neither likely nor unlikely; 2. Rather unlikely; 1. Very unlikely; Don't know/ Prefer not to answer; Not answered	Weighted average of Likert scale	1, 2, 3.
During the COVID-19 pandemic have you lost your job(s)/contract(s)?	Yes_ permanently; Yes_ temporarily; No	Yes_ permanently; Yes_ temporarily	1.
When you compare the financial situation of your household 3 months ago and now would you say it has become better, worse or remained the same?	Better; The same; Worse	Worse	1, 2, 3.
Thinking of the financial situation of your household in 3 months time do you think it will become better, worse or remain the same?	Better; The same; Worse	Worse	1, 2, 3.

Source: Author

3 Results of the research

As was mentioned in the methodology the purpose of the research presented in this article is to analyze where Slovakia stands in term of job security and financial stability of citizens in comparison with other EU countries.

Firstly, we focused on job security. Motivation for this kind of research is to find out whether Slovakian citizens are more afraid of losing the job during the COVID-19 pandemic than other EU citizens. As a base, we used the question: “Using this scale, how likely or unlikely do you think it is that you might lose your job in the next 3 months?” and rank the answers to numbers on Likert scale from five (very likely) to one (very unlikely). Then we calculate weighted average for every country where, weight represent percentage of citizens of particular EU country which answered with particular answer and the rank of the answer represented the value. The box-plot analysis of the EU countries average is presented in Figure 1. The dashed line represents Slovak average in First lockdown period, dotted line represents Slovak average in Reopening period and dash-dotted line represent Slovak average in Year after period.

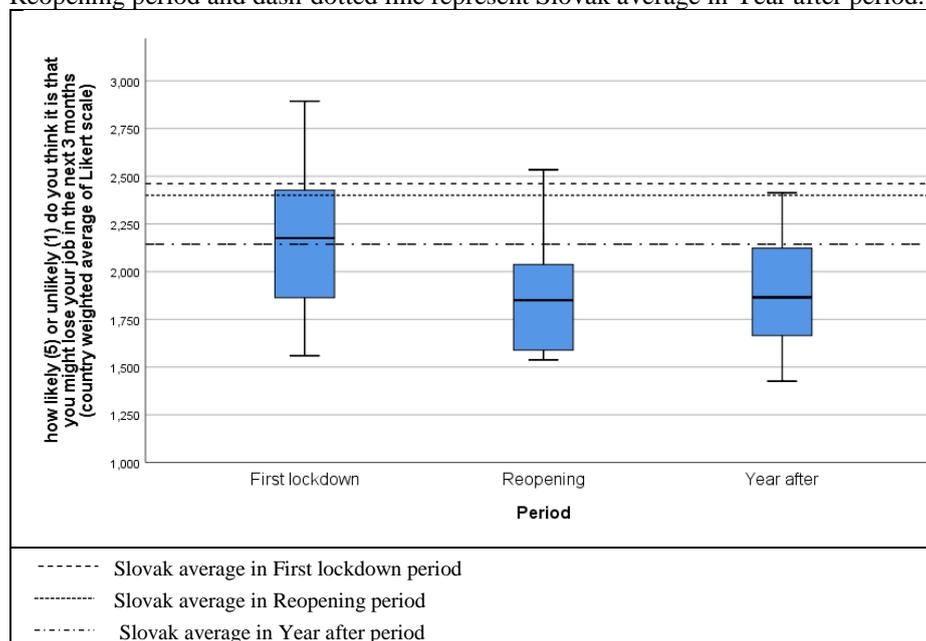


Figure 1. Box plot analysis of likeliness of losing job, *Source: Author*

As can be seen in Figure 1, European median in the first period of data collection is lower than 2,25, which is closer to answer 2. Unlikely than to answer 3. Neither likely nor unlikely. Moreover, the European medians for other two periods are lower than 2., that mean that they are within the area representing the answers 1. Very unlikely and 2. Unlikely. Situation is quite different when we analyze Slovakian values. The averages representing the Slovak responses are higher than 2 in all three researched periods. They are considerably higher than European medians in all three researched periods and there are also higher than third quartiles of particular periods. That means that more than 75% of countries have response average lower than Slovakian average during all three periods of COVID-19's European outbreak. The Slovakian value from third period represents 95% percentile, which mean that only 1 country (Greece) have higher average than Slovakia.

In the next step, we measured what percentage of respondents actually lost the job or contract during the first three months of COVID-19's European outbreak. The research was based on the question: During the COVID-19 pandemic have you lost your job(s)/contract(s)? The motivation behind this kind of research is to determine whether there was a higher probability for Slovakian citizens to lose a job than it is for citizens from other EU countries. We focused on answers Yes, permanently and Yes_temporarily. To obtain more precise image about job security in Slovakian workplace, we decided to distribute analysis based on gender and age. The motivation for such approach is to determine whether one gender or age group of Slovakian citizens have higher probability of losing job than others in comparison with other EU countries. The EU countries' distribution of percentage of people who permanently or temporarily lost job of contract during first three months of COVID-19's European outbreak pandemic based on they genders is presented in the Boxplot analysis below.

(Figure 2) The dashed line represents Slovak value for male, dotted line represents Slovak value for female.

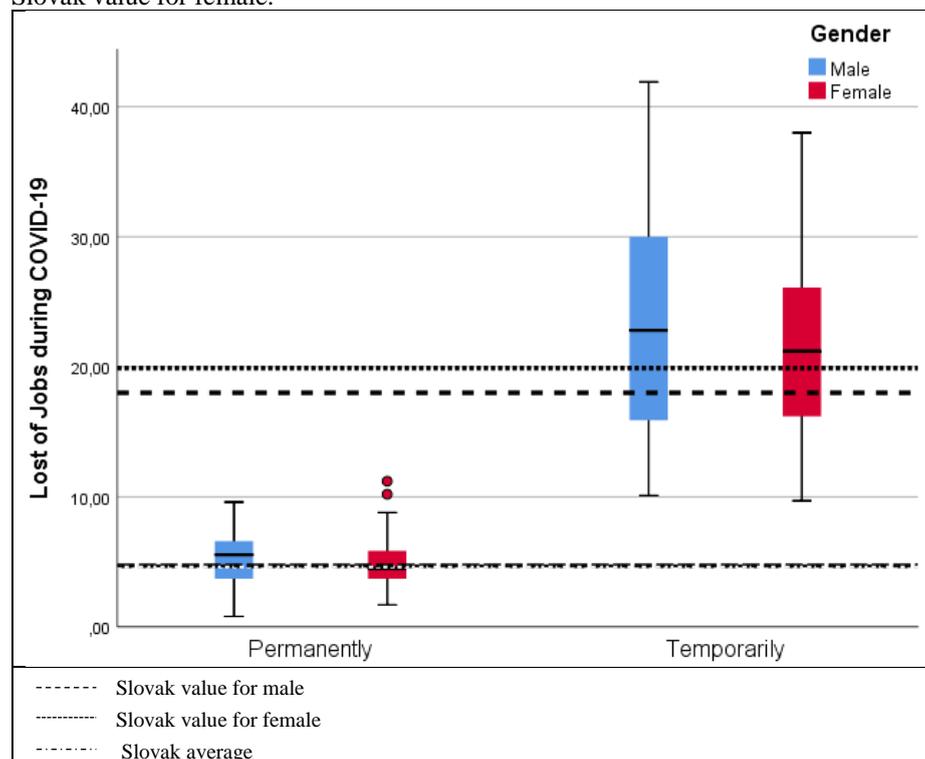


Figure 2. Box plot analysis of European countries' probability of losing job based on gender, Source: Author

As can be seen in Figure 2, boxplots representing permanent loss of jobs have significantly lower variability than boxplots representing temporarily loss. The medians of formerly mentioned boxplots are more than five times lower than median of lastly

mentioned ones. Moreover the performed Wilcoxon signed-rank tests could not confirmed at 5% significance level that there are statistically significant differences between genders both for samples representing permanent loss of jobs (H1) as well as temporarily ones (H2). The Table 2 shows overview of these tests.

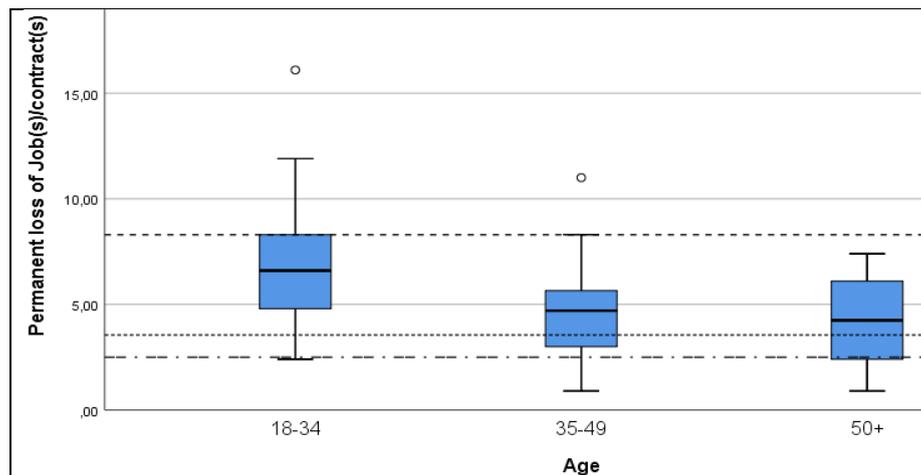
Analysis of Slovakian values showed that Slovakian values are below European medians for all groups except for females who permanently loss of job. The Slovak value representing this group is 0,1% higher than median.

Table 2. Overview of tested hypotheses

	Null Hypothesis	Test	Sig.	Decision
H1	The median of differences between Permanently_M and Permanently_F equals 0.	Related-Samples Wilcoxon Signed Rank Test	,807	Retain the null hypothesis.
H2	The median of differences between Temporarily_M and Temporarily_F equals 0.	Related-Samples Wilcoxon Signed Rank Test	,745	Retain the null hypothesis.

Source: Author

Besides gender-oriented analysis, we also conducted age-oriented analysis, too. Here we studied only permanent job loss. The box plot analysis of the EU countries' distribution of percentage of people who permanently lost job of contract during first three months of COVID-19's European outbreak pandemic based on their age is presented below. (Figure 3) The dashed line illustrates Slovak value representing 18-34 age group, the dotted line shows Slovak value representing 35-49 age group and the dash-dotted line depicts Slovak value representing 50+ age group.



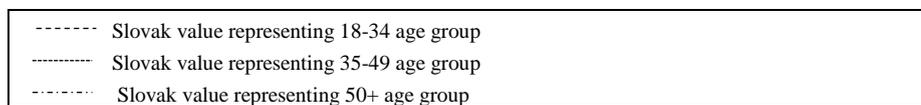


Figure 3. Box plot analysis of European countries' probability of losing job based on age, *Source: Author*

Boxplot analysis presented in the aforementioned graph showed that medians of distributions decline across ascending age group. The boxplot representing youngest group of respondents has highest median. Although the boxplot representing age group of 50+ has lower median, it has also highest variability. The results are quite different where we compare Slovak value to European distribution. For age groups 35-49 and 50+ the Slovakian values are considerably lower than European's medians. Moreover, Slovak value for age group 50+ is close to second quartile, which means that 75% EU countries have higher job loss percentage for age group of 50+ than Slovakia. Belgium, Sweden, Austria, Denmark, Finland and Estonia represent a lower percentage of job loss than Slovakia. In term of youngest age group, Slovak value is equal to third quartile of appropriate distribution which mean that 75% of EU countries have lower job loss percentage than Slovakia, for example Belgium, Austria and Hungary represent a higher percentage of job losses than Slovakia.

Second part of research is dealing with financial situation of EU citizens. Here we analyse current and future (expected) financial condition of EU household in different periods of COVID-19's European pandemic outbreak. In term of current condition, we use question: When you compare the financial situation of your household 3 months ago and now would you say it has become better, worse or remained the same? For the purpose of this study, we were focused only on samples which represent response: worse. Boxplot analysis presented in the Figure 4 showed EU countries' distributions of percentage of response worse for different period of COVID-19 outbreak. The dashed line represents Slovakian value in First lockdown period, dotted line represents Slovakian value in Reopening period and dash-dotted line represent Slovakian value in Year after period.

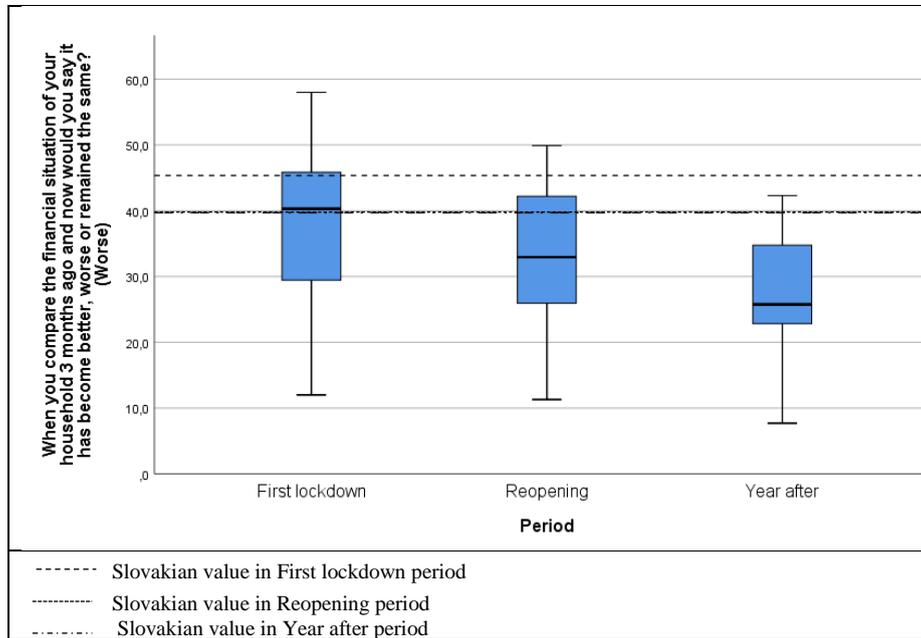


Figure 4. Distribution of EU countries' percentage of households with deteriorating financial condition, *Source: Author*

The boxplot analysis presented above showed that with continuation of outbreak median of European countries were decreasing around 5% per period. Also interquartile ranges of boxplots which represent answers of 50% countries were decreasing from one period to another. Analysing Slovakian results, we were able to spot decrease in values from 45,3% to 39,8% but only from first period to second one. On the other hand, difference in values between second and third period was not considerable because it was only 0,1%. Slovakian values from all three periods were considerable higher than appropriate European median. Results also showed that Slovakian value in first lockdown period is close to third quartile of made from European countries. In other words, that means that nearly 75% of EU countries have lower percentage of people, which perceive that their household's financial situation was worsen than three months before first lockdown. Croatia, Hungary, Cyprus, Bulgaria, Greece and Romania have higher percentage of people, which perceive that their household's financial situation was worsen than three months before first lockdown. Situation is even more unfortunate when we analyse data from Year after period. Slovakian value in the third period represents 95% percentile of distribution of European countries. This mean that out of 27 EU countries, each with the exception of Bulgaria, had a lower percentage of people, which perceive that their household's financial situation was worsen than three months before Year after period of COVID-19 European outbreak (February/March 2021).

Next round of analysis covered expectation of European citizens regarding financial future of their households in the next three months. The research was based on the

question: Thinking of the financial situation of your household in 3 months' time do you think it will become better, worse or remain the same? This study focusses only on respondents, which answered worse. Motivation for this kind of investigation was determine how EU citizens' expectations of their incoming deteriorating financial situation changes during the different period of European COVID-19 outbreak. Other objective of the study is to compare expectation of Slovakian citizens with the expectation of citizens in other EU countries. The boxplot analysis of the results is presented below in the Figure 5. The dashed line represents Slovakian value in First lockdown period, dotted line represents Slovakian value in Reopening period and dash-dotted line represent Slovakian value in Year after period.

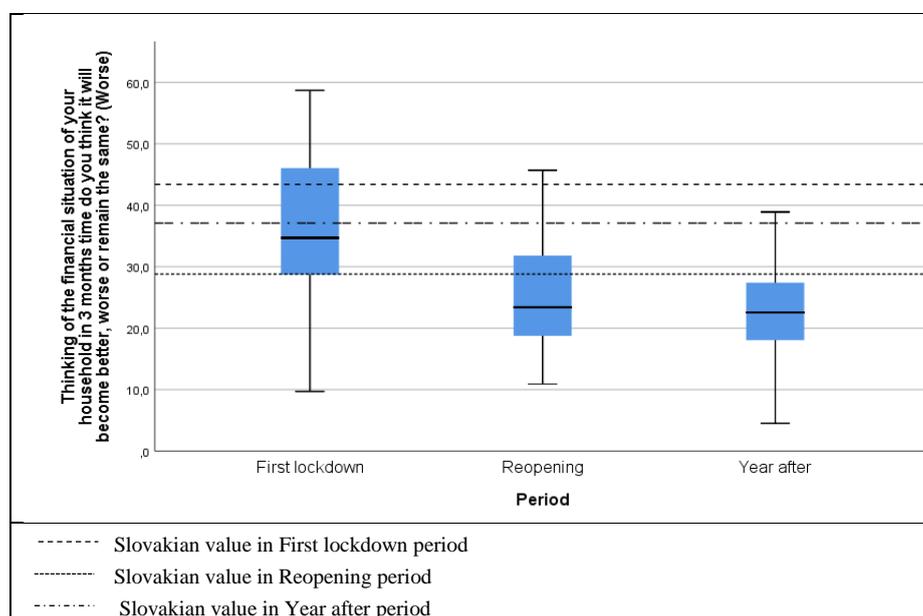


Figure 5. Distribution of EU countries' percentage of households which expect deteriorating financial condition, *Source: Author*

Boxplot analysis exhibited in Figure 5 shows decline in the medians with continuation of COVID-19 European outbreak. Biggest decline in medians reaching almost 10% was recognized between first and second period. Apart from this the difference in medians between second and third period was 3%. This result suggests that with ongoing outbreak, there is a declining percentage of people in EU countries who expect that financial situation of their household will be worse in three months. On the other hand this is not the case of Slovakia. Similar to previous results the Slovakian values are bigger than European median for all three periods. On the other hand, for first two periods, Slovakian values were within interquartile range of appropriate boxplots, Interquartile range (size of the box) represents answers of 50% countries around the median, which can be interpreted as values inside the range are not considerably high or considerably low. Situation is very different for last period

Year after. Here the Slovakian value represent 95% percentile. In other words, this mean that one year after COVID-19's European outbreak, every country in the 27 EU countries except Greece reports a lower percentage of people, which expect that financial situation of their household will be worse in three months.

Further analysis showed that results presented in Figure 5 are similar to results presented in Figure 4. This finding is also supported by conducted correlation analysis (see Figure 6). We use Spearman rank correlation coefficient to measure association between answers presented in Figure 4 and answers presented in Figure 5. The value of the coefficient was 0,875 (p -value<0,001). Such result led to assumption that in EU countries where high percentage of citizens perceive deterioration of their financial situation in last three months before taking study, there is also a high percentage of citizens which expect deterioration of their financial situation for the next three months and vice versa.

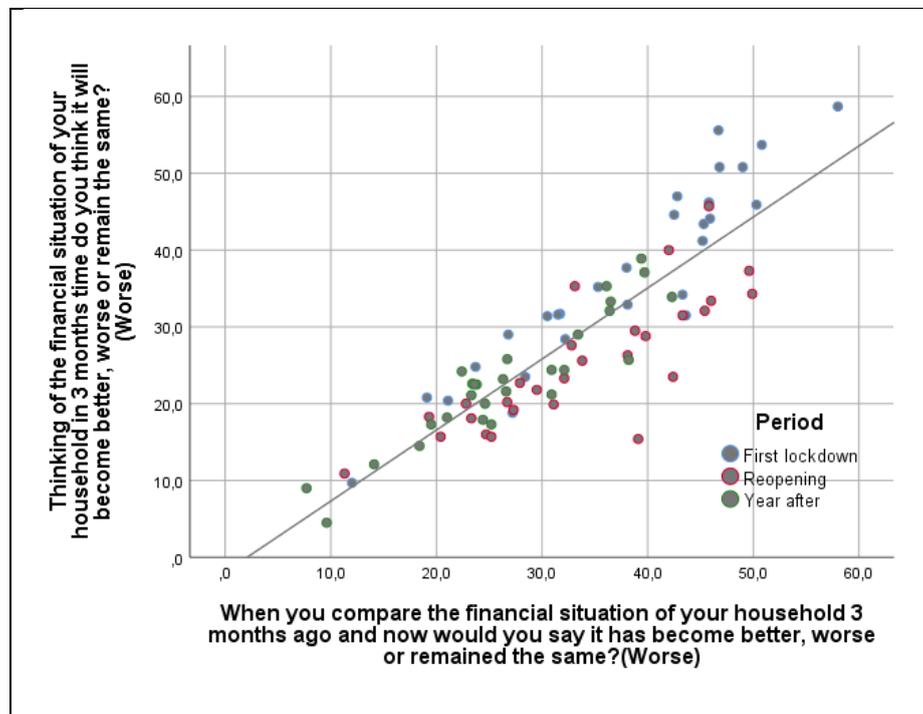


Figure 6. Scatterplot of questions used in correlation analysis, *Source: Author*

4 The conclusion

The presented paper tries to measure impact of COVID-19's European outbreak on job security and financial stability of Slovakian citizens in comparison with other EU countries. Research is based on more than 135 000 answers from respondents across Europe which were collected during the three different periods of pandemic. In term

of job security, the results showed that most of citizens in most of EU countries thought that it was unlikely or very unlikely that they lose their job in the next three months. These results were consistent during all three examined periods. On the hand Slovakian averages were close or higher than third quartile for every sample in all three periods. It means that citizens of at least 75% of EU-27 countries decided that on average it is for them more unlikely (less likely) to lose job than it is for Slovakian citizens. Moreover, in last period, in each of the 27 EU countries except Greece decided that on average it is for them more unlikely (less likely) to lose job than it is for Slovakian citizens. This was analysis of the citizens expectations. The results were not so horrified for Slovakia when we study percentage of people who actually loss job in the first three months of pandemic. The percentage of Slovakian male and female, who permanently or temporarily lost their job or contract do not surpass European median. Percentage of respondents, who permanently loss their jobs was under the European median for age groups 35-49 and 50+. On the other hand, 75% of EU countries have lower percentage of 18-34 years old people, who permanently loss their job during first few months of pandemic. Bulgaria, Hungary and Poland have higher percentage of 18-34 years old people than Slovakia, who permanently loss their job during first few months of pandemic.

Second important part of research was financial stability of Slovakian and European households. Here we focused only on percentage of citizens whose household's financial situation worsen in last three months from taking the questionnaire. We also analysed citizens who expected that their household's financial situation will be worse in next three months from taking the questionnaire. Interestingly the results were very similar for both groups of previously mentioned citizens, which was confirmed by realized correlation analysis. Results showed that in term of Europe percentage of people whose financial situation worsen in last three months decline by 5% from one reviewed period to another. Decline was also present in data representing countries' percentage of people who expected that their household's financial situation will be worse in next three months. From one period to another, mentioned percentage decreased. On the other hand, this kind of decline was not present in Slovak data. The discrepancies between European data and Slovak dataset mainly occur in Year after period. The period includes data, which were collected roughly one year after COVID-19's European outbreak. This dataset's responses showed, that after Slovakia, only one country (Bulgaria) out of 27 EU countries have higher percentage of people who think that their financial situation worsen in last three months. Similarly, the data also showed that after Slovakia, only one country (Greece) out of 27 EU countries have higher percentage of people who think that their financial situation will be worse in next three months. The authors understand that COVID-19 spreads differently in every EU country and that these countries implement different countermeasures to fight this pandemic. This is the reason why the purpose of this paper was only to present changes in EU citizens' perceptions during three important periods of COVID-19's outbreak and compare them with situation in Slovakia. Only the further research based on aftermath data will be able to tell whether presented perceptions were justified or biased.

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Changes in the density and location of supermarkets in Bratislava

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Abstract. The main area of research is the dynamically developing capital city Bratislava and traditional supermarkets in its territory. The aim of the article is to examine the changes in the number of supermarkets in Bratislava and its districts between 2016 and 2021. In this publication, we apply analysis and synthesis in all phases of problem solving. We also use induction, deduction and the method of comparison. Finally, we apply the entropy calculation in a figurative sense to retail geography. The result will be the density of coverage of supermarkets in Bratislava and its individual city districts as a prerequisite for future development and in-depth research devoted to this issue.

Key words: Location, Geographical Concentration, Supermarkets, Entropy

JEL Classification: C23, M31, R12

1 Introduction

The dynamically growing capital city of Bratislava attracts the attention of retail geography, which forms the core of this article. Due to the constantly changing population and high mobility, besides the construction of new housing units as well as workplaces, this city is interesting also for the construction of new retail stores. Under this term in the article, we mean traditional stone supermarkets with food assortment. The issue is very lively and therefore needs to be constantly observed and latest changes to be recorded. The main question is whether the coverage and distribution of all supermarkets in Bratislava and its districts is sufficient for consumers.

The aim of the article is to examine the changes in the number of supermarkets in Bratislava and its districts during the period between 2016 and 2021.

We observe the situation in the capital during the mentioned timeframe and we record changes in the number and density of supermarkets within individual city districts. Based on the obtained data, we calculate the relative entropy. The resulting

information serves as a basis for further research devoted to the related issues examined in depth.

2 Current state of the problem

Several authors deal with the mentioned topic focusing on the concentration of retail units in cities. By defining the theoretical and actual number of retail units and comparing these two numbers, the authors obtained information on the surplus and deficit of retail units in individual cities (Bilková and Križan, 2013). Authors such as Lang, Marcon, and Puech see special concentration outcome through a methodology that is based on the distance used to improve the spatial economy of all economic activities through accurate assessments of spatial organization (Lang, Marcon, Puech, 2016).

2.1 Supermarkets

Recently, retail has undergone changes. At present, apart from the epidemiological situation in the world, the consumer is looking for a supermarket, where he will also get his senses stimulated. It is a form of a traditional supermarket where the consumer can enjoy small snacks in various forms, before, during or after shopping. Shopping thus becomes an experience. According to the author Kotler, retail includes all activities related to the sale of goods or services directly to the final consumer for personal, non-commercial use. Any organization can be involved in this type of sale, be it a manufacturer, wholesaler or retailer. It does not matter how and where the goods or services are sold (Kotler, 1995). The online world of which we are a part, pushes us into shopping from the comfort of living-room using the internet. However, from the point of view of retailers owning grocery stores, their biggest benefit is that the online supermarket cannot compete in creating the so-called shopping experience. Customers welcome options such as breakfast in the supermarket, especially in the big cities. In Slovakia, therefore, we focus mainly on the capital, where, for example, in the most recent networks of YEME supermarkets, they provide the aforementioned services.

2.2 Geographical concentration

From the point of view of location, it is necessary to pay attention to retail outlets that already exist and to build new stores on the basis of these data. Consumer preferences must also be taken into account. The existence of retail units at the interregional and regional level is mainly due to the right strategy based on a precise analysis of the market environment (Cimler, 1994; Kunc et al. 2012). Another important factor that will tell us a lot about the correct location is the population density in a given place. At first glance, it may seem that the problem of the lack of stone retailers affects more rural areas, but this is not the case. In cities, although the supermarket has some form

of accessibility, it depends on the overall availability from the consumer's point of view. This is very closely related to the customer's income level, supermarket prices and location (Karamychev, van Reeve, 2009). There are two options here: food is economically available but not located in the area or food occurs in the locality but is not accessible from an economic point of view, e.g. the goods are sold out or too expensive.

The ideal sample is a city like Bratislava, because a large portion of the population is concentrated here. There are several reasons why this is so. First of all, Bratislava creates many job opportunities, hosts many universities and students and last but not least, new buildings are growing really fast. All the above facts are closely related to our issue, i.e. the construction of new retail stores and their proper location. The food market has a clear tendency to concentrate, leading to the creation of global businesses (retail chains) and strategic business alliances. Concentration also takes place at the level of organizational and spatial accessibility (retail units are concentrated in the shopping center, retail space, etc.) (Jánska et al. 2017).

3 Methodology

The presented article can be characterized as analytical in terms of the methods used. The methods used correspond to the article's character, especially general scientific methods, analysis and synthesis in all phases of solving the problem. At the same time, we use scientific and philosophical methods such as induction and deduction, the method of comparison. Finally, we use a method known for retail geography, entropy calculation.

The concept of entropy is based on the basic law of physics, according to which everything leads to a state of maximum disorder or randomness. Using the entropy calculation formula, we can measure the spatial variance of the population. Entropy in a figurative sense can also be used to calculate the concentration of supermarkets in the capital. The more dispersed the population in the universe, the higher the entropy. To approximate the concept of entropy, it should be noted that geographers use it to measure the outflow of people from the countryside. When the entropy is low, the dispersion of the population decreases, and thus the concentration of the population is higher (Cliquet G., Fady, A., Basset G., Groizean J-P., 2006).

The aim of the article is to examine the changes in the number of supermarkets in Bratislava and its districts during the period between 2016 and 2021.

The research took place in Bratislava, the capital of Slovakia, as it is the largest metropolitan area in Slovakia. The method consists in determining the geographical distribution of all supermarkets with food assortment and their concentration in Bratislava using digital maps from Google and subsequent calculations according to the formulas below.

Based on the defined goal, a hypothesis was formulated:

The total density of coverage of supermarkets in Bratislava and its districts increased in 2021 compared to 2016.

3.1 Calculation of relative entropy

The formula for calculating entropy applied to supermarkets assumes that with their development will increase their area coverage.

Formula used to calculate the territorial coverage of supermarkets in Bratislava:

$${}^k\mathbf{E} = - \sum \mathbf{f}_i * \log \mathbf{f}_i \quad (5)$$

$i = 1$, where:

E -entropy

k -number of divided geographical areas

\log -logarithm

f_i -number of retail units within the area

Relative entropy application:

$$\mathbf{RE} = \mathbf{E} / \log \mathbf{k} \quad (3)$$

k is calculated in the interval $[0, 1]$ to ensure the simplest comparison with the competition (Cliauet G., Fady A., Basset G., Croizean J-P., 2006). To calculate the relative entropy in Bratislava, $k = 5$ due to the administrative division into 5 districts (Bratislava 1, Bratislava 2, Bratislava 3, Bratislava 4, Bratislava 5).

Table 1 Number and type of stores by brand in Bratislava in 2016 and in 2021¹

Brand	Type of store	No. of stores	No. of stores
		2016	2021
Billa	supermarket	20	27
Carrefour	hypermarket	2	0
CBA	supermarket	3	1
DELIA	small shop	9	31
Jednota	supermarket	4	3
Kaufland	department store	6	7
KON-RAD	supermarket	1	1
Lidl	discount supermarket	16	18
Malina	small shop	5	28
Môj obchod	small shop	8	9
Samoška	supermarket	7	1
Terno	supermarket	11	43
Tesco	hypermarket/supermarket	26	30
YEME	supermarket	1	4

¹ Source: Jánska et al. 2017, Own processing

Sum	119	203
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Table 1 shows the number of retail units per chain in 2016 and 2021. Based on the data obtained in 2021, the highest number of stores have Terno and Delia. The decline occurred between retail chains such as Samoška, Carrefour and CBA. There were no changes in KON-RAD stores. The newest retail chain on the market is the YEME food network.

Table 2 Distribution of stores in the city districts of Bratislava in 2016 and in 2021²

Year	BA I	BA II	BA III	BA IV	BA V	Sum
2016	20	32	20	18	29	119
2021	38	58	40	26	41	203

Table 2 quantifies the number of supermarkets in individual city districts of Bratislava. In 2021, most food chains were concentrated in the district of BA II - Podunajské Biskupice, Ružinov, Vrakuňa. On the contrary, the lowest number of stores is found in the district of BA IV - Devín, Devínska Nová ves, Dúbravka, Karlova Ves, Lamač, Záhorská Bystrica. The total number of retail units increased by 84 supermarkets during the research period.

4 Results and discussion

The article focuses on supermarket chains, while assuming that they provide a complete range of fresh foods at low cost and profit margins (Jánska et al. 2017). This is consistent with, for example, the work of Leat et al. (2011). In 2016, field research located 119 stores under 14 chains (Jánska et al. 2017). In 2021, the survey of supermarkets was made on the basis of data collected from digital maps from Google and brands' websites.

Table 3 Calculation of relative entropy for a complete set of supermarkets in individual districts of Bratislava in 2016³

District	f_i	$\log f_i$	$f_i \log f_i$
Bratislava 1	0,168067	-0,774517	-0,130171
Bratislava 2	0,268908	-0,570397	-0,153384
Bratislava 3	0,168067	-0,774517	-0,130171

² Source: Own processing

³ Source: Jánska et al. 2017

Bratislava 4	0,151261	-0,820274	-0,124075	
Bratislava 5	0,243697	-0,613149	-0,149423	
	E	k	log k	RE
	0,687224	5	0,69897	0,983195

Table 4 Calculation of relative entropy for a complete set of supermarkets in individual districts of Bratislava in 2021⁴

District	f_i	$\log f_i$	$f_i \log f_i$	
Bratislava 1	0,187192	-0,727712	-0,136222	
Bratislava 2	0,285714	-0,544068	-0,155448	
Bratislava 3	0,197044	-0,705436	-0,139002	
Bratislava 4	0,128079	-0,892523	-0,114313	
Bratislava 5	0,201970	-0,694712	-0,140311	
	E	k	log k	RE
	0,685297	5	0,69897	0,980438

Tables 3 and 4 show the relative entropy of all supermarket chains in Bratislava in 2016 and 2021. In the current research, we do not need to distinguish between the size of supermarkets or their mutual competition. We are currently interested in the number of stores in Bratislava. The calculation is performed for all five districts of the capital. It is necessary to calculate a non-standard number of decimal places for the accuracy of the result.

Table 5 Calculation of relative entropy for individual supermarket chains in 2021⁵

Brand	E	log k	RE
Billa	0,68534	0,69897	0,98050
CBA	0	0,69897	0
DELIA	0,58179	0,69897	0,83235
Jednota	0,27643	0,69897	0,39549
Kaufland	0,58707	0,69897	0,83991
KON-RAD	0	0,69897	0

⁴ Source: Own processing

⁵ Source: Own processing

Lidl	0,64879	0,69897	0,92820
Malina	0,56515	0,69897	0,80855
Môj obchod	0,49903	0,69897	0,71395
Samoška	0	0,69897	0
Terno	0,67171	0,69897	0,96100
Tesco	0,67382	0,69897	0,96402
YEME	0,60206	0,69897	0,86135

Previous calculation is needed as a basis for future research, which will take into account the competition between supermarkets and a deeper analysis according to their size.

The value of f_i and $f_i \log f_i$ was calculated for each retail brand in order to obtain the relative entropy of each retail chain in Bratislava.

In 2016, KON-RAD was the only chain to reach an entropy value of 0. On the contrary, Tesco achieved the highest entropy value in 2016 (Jánska et al. 2017).

From the above table no. 5, we can interpret that KON-RAD did not change in terms of entropy compared to 2016, on the contrary, CBA and Samoška networks with entropy 0 have been reduced in Bratislava till 2021. It follows that the three mentioned retail chains have poor coverage in Bratislava. Networks such as Billa, Terno and Tesco represent the strongest coverage. This means that they serve the major territory of Bratislava.

Given the fact that the population of Bratislava is constantly growing, we believe that this factor is closely related to the growth of supermarkets in the same area. Where demand grows, so does supply. During the years we studied, the largest increase in the number of inhabitants in Bratislava was recorded in 2019 (Open Data Bratislava, 2019). The Statistical Office speaks of an increase of 4862 citizens (Štatistický úrad Slovenskej republiky, 2019).

5 Conclusion

The hypothesis: " The total density of coverage of supermarkets in Bratislava and its districts increased in 2021 compared to 2016." was confirmed.

Based on the data from Table 2, we can confirm that there was a significant increase in the number of stores in each of the five districts of Bratislava. The largest increase was recorded in the district of BA II. Compared to 2016, the number of stores increased by 84 new retail stores located in 2021.

The results of relative entropy for the capital as a whole compared to two milestones 2016 and 2021 show a negligible decrease in relative entropy. Despite this finding, we can state that the value of relative entropy currently indicates a significant coverage by retail stores in Bratislava. For consumers, this means that the city has enough traditional supermarkets. In 2021, in the district of Bratislava IV, we observe the largest decline

in the coverage of food chains. At the same time, we record the most significant increase in retail coverage in the Bratislava III district.

From Table 5 we can deduce that some supermarket chains are gradually disappearing and being replaced by new networks such as YEME, where the customer gains a shopping experience - experiential marketing. To keep the entropy high, it is necessary to constantly monitor the problem along with changing external factors.

The retail market in Slovakia, like the markets of other Central European countries, is characterized by an enormous increase in distribution concentration and radical changes in distribution channels. Most supermarkets in retail chains have a centralized shopping and distribution centers. Supermarkets account for a large portion of processed or fresh food sales among a limited number of preferred suppliers. Territorial changes in the distribution of supermarkets will continue to reflect changes in food demand, current trends in healthy food, changes in settlement or the creation of new districts (Jánska et al. 2017).

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Patent Box in Slovakia – success or failure?

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Abstract: The aim of the paper is the analysis whether the introduction of the patent box in Slovakia as from 1/1/2018 was effective or not and if it is a useful tax incentive to support the investment into R&D.

Keywords: patent box, software, tax incentive, corporate income tax

JEL classification: F21, H25, H73

1 Introduction

The patent box has been introduced in Slovakia since 1/1/2018. The aim of this article will be the analysis whether this new tax incentive for those having patents, utility models or inventing software was a success or failure. In order to define whether the introduction of this tax incentive can be deemed to be success we should first look at the website of the Slovak financial administration (www.financnasprava.sk). In line with the Slovak Income Tax Act¹ (further only SITA) one can find there the data on the taxpayers who have made use of the patent box pursuant to Art. 13a and 13b of the respective Act. You can find there following disastrous picture:

Table 8. Taxpayers making use of the patent box in line with the §13a SITA in 2020
(Source: <https://www.financnasprava.sk/sk/elektronicke-sluzby/verejne-sluzby/zoznamy>)

ATLANTIDA- Dom seniorov, n.o.	Chorvátsky Grob	90025	Na pasienku 1/A	SK	602519.09
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¹ Act No. 595/2003 Coll. Income Tax Act as amended

ILYO Taekwondo Zvolen	Zvolen	96001	E. M. Šoltésovej 2139/26	SK	489.01
Myslím - centrum kultúry Nepočujúcich	Bratislava - mestská časť Ružinov	82108	Jelačičova 4	SK	27926.28
O DUŠU - psychologická pomoc a podpora duševného zdravia	Žilina	1001	Nám. gen. M. R. Štefánika 894/13	SK	3145.00
OBEC Veľké Dvorníky	Veľké Dvorníky	92901	190	SK	13.89
Podniková odborová organizácia OZ PBGN SMZ, a.s. Jelšava	Jelšava	4916	Jelšava	SK	1470.81
Poľovnícke zdrúženie KLÍŽSKA NEMÁ	Klížska Nemá	94619		SK	2550.00
Poľovnícky spolok Dedinka Dolný Štál	Dolný Štál	93010	Mostová 33/6	SK	1550.00
RESCO spol. s r.o.	Bratislava - mestská časť Ružinov	82109	Mlynské nivy 5	SK	688828.53
Slovenská komora iných zdravotníckych pracovníkov	Bratislava - mestská časť Ružinov	82658	Drieňová 27	SK	46249.94
Spoločenstvo vlastníkov bytov J. Alexyho 5 Bratislava	Bratislava - mestská časť Dúbravka	84101	J. Alexyho 5	SK	900.00
Sygic a. s.	Bratislava - mestská časť Ružinov	82109	Twin City C, Mlynské Nivy 16	SK	186544.05
Telegrafia, a.s.	Košice - mestská časť Staré Mesto	4001	Lomená 7	SK	508110.91
Tob-Top, s.r.o.	Svidník	8901	Gen. Svobodu 684/12	SK	2414.76
Zdrúženie vlastníkov lesných pozemkov PS Liptovské Revúce	Liptovské Revúce	3474	Liptovské Revúce 116	SK	1.12

If you look closer you will find only 3 or 4 companies which have really made use of the patent box. The remaining entries are errors (for examples NGOs, which have made use of the general exemption from the corporate income tax in line with SITA). If the first form of patent box (the easier one to make use of) has been used only by 3 companies, then this measure is a clear failure. In our contribution we will analyze the reasons for this status quo and will try to make few recommendations to improve the legislation or the implementation of this tax incentive.

It makes very much sense that the Slovak Ministry of Finance had come to the idea to introduce this kind of a tax incentive. If this had not happened the research and development would never be shifted to Slovakia or the outcome of the research and development made in Slovakia would be marketed/sold in other jurisdictions where the patent box had been introduced in past.

However, we should bear in mind, that it is not enough to introduce such a measure without thinking of the pragmatic and practical impact it will have and the way how it is regulated in the law. In case of the Slovak patent box it seems that the intention was brilliant, however the legislative regulation and conditions are too difficult for companies to fulfill. This unpleasant situation is the reason for preparation of this contribution and we hope to provide good points to reshape this tax measure. Before starting with the analysis, let us give you some international and local theoretical background on this issue.

2 Theoretical background

2.1 International context

According to the latest official statistics for research and development (R&D) as indicated in the OECD Main Science and Technology Indicators database which was published recently on 18 March 2021 the data show that prior to the onset of the COVID-19 pandemic, R&D expenditure in the OECD area grew in real terms by 4% in 2019 (OECD MSTI database, 2021). OECD R&D intensity (domestic expenditure on R&D expressed as a percentage of gross domestic product (GDP)) rose from 2.4% in 2018 to nearly 2.5% in 2019. After stagnating between 2013 and 2016, R&D intensity in the OECD area has been steadily rising. In fact, the OECD area has not seen comparable growth over a three-year period since the mid-1980s. The highest growths have been observed in the US, Germany, Israel and Korea with more than 3 % growth. the EU27 area experienced only a more modest increase to 2.1%.

R&D investment is an important source of long-term productivity and economic growth. Below you can find a overview of the effective tax rate on R&D in the OECD countries in the year 2020 (OECD MSTI database, 2021).²

Table 2. Effective Average Tax Rate for R&D in 2020, Source: https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB

Year	2020		
Effective Average Tax Rate for R&D			
Country	(%)		
Australia	22,69	Latvia	18
Austria	14,53	Luxembourg	22,87
Belgium	12,3	Mexico	25,94
Canada	17,88	Netherlands	15,92
Chile	9,45	New Zealand	17,33
Colombia	14,85	Norway	9,41
Czech Republic	6,69	Poland	4,18
Denmark	16,2	Portugal	7,59
Estonia	18	Slovak Republic	-6,47
Finland	18,28	Slovenia	6,59
France	11,59	Spain	8,41
Germany	18,48	Sweden	14,03
Greece	8,47	Switzerland	19,44
Hungary	-1,49	Turkey	15,78
Iceland	3,31	United Kingdom	11,46
Ireland	-3,15	United States	20,12
Israel	21,07		
Italy	15,83		
Japan	19,29		
Korea	24,04		
Lithuania	-2,59		

² https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB

Slovakia seems to have the most favorable and effective rate to tax R&D. If this were the case, there would be much more companies opting to make use of the patent box. On the other hand there is not only the patent box, but more likely the brilliant points can be achieved in Slovakia due to very entrepreneur-friendly policy when it comes to R&D deduction. The possibilities to deduct cost for R&D are up to 3 times.

The latest analysis of the European Commission called Annual Report for Taxation in Europe for 2021 gives an overview what kind of tax R&D incentive is provided in the EU countries. Surprisingly Slovakia offers all 4 kinds of tax incentives, however with very varying success for each kind of tax R&D benefit. Here is the respective overview:

Table 3. R&D Tax Incentives by Member state (2019), Source: EC Annual Report on Taxation 2021

Total	Patent box	Tax credits	Enhanced allowance	Accelerated depreciation
EU-27	14	17	14	19
BE	•	•	•	•
BG				•
CZ		•	•	•
DK		•	•	•
DE		•		•
EE				
IE	•	•		•
EL			•	•
ES	•	•		•
FR	•	•		•
HR			•	
IT	•	•	•	•
CY	•			
LV			•	•
LT	•		•	•
LU	•	•		•
HU	•	•	•	•
MT	•	•	•	
NL	•	•		•
AT		•		
PL	•		•	•
PT	•	•		
RO			•	•
SI		•	•	
SK	•	•	•	•
FI				•
SE		•		

Evidence suggests that patent/IP boxes do not necessarily stimulate R&D and can be used as a profit-shifting instrument. Overall, patent/IT boxes seem likely to be an ineffective, inefficient way of supporting R&D (CPB, 2014). This was the conclusion of the abovementioned study financed by the European Commission in 2014. Since

then there have been a lot changes in terms of finetuning the patent box system across Europe. Particularly the issue of own patents (not purchased IP) has been a topic and for the moment a requirement, if a patent box does not want to be deemed as aggressive tax planning (ATP). From the table no. 3 you might recognize that Slovakia has introduced all 4 kinds of tax incentives. While the R&D deduction has become a very solid and effective tax instrument, this is not the case for the patent box.

The R&D state support can be executed in principle in two ways, namely through direct public support and then through tax incentives. In Slovakia the tax incentives are the preferred way by the Slovak government. You can learn the figures for other countries in the graph below.

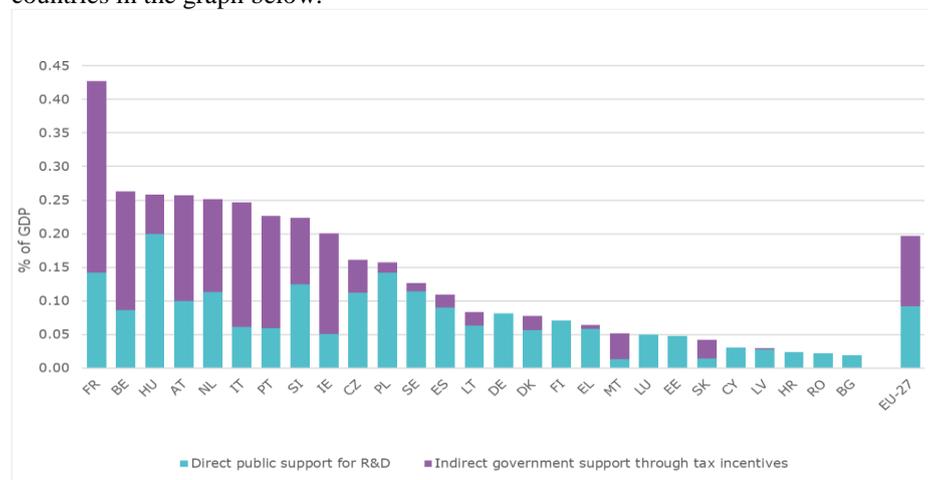


Fig. 10. Division of the state aid between direct public support for R&D and indirect government support through tax incentives (Source: EC Annual Report on Taxation 2021)

When analyzing the effectivity of various patent boxes, it is needed to stress, that in several countries, the IP incentive like the patent box have undergone already a long journey. OECD is trying to continuously look at the different preferential IP regimes in different countries and is trying to identify which of them are harmful for the tax competition in the world. The important criterion when any IP regime is deemed to be harmful is in cases, when the IP (patent, software) is not produced/created within the company but is purchased from a third party. OECD has forced countries to amend their legislations accordingly in order to comply. This approach had been recommended by the BEPS 5 Action on harmful tax practices which has introduced the nexus criterion. The OECD Corporate Tax Statistics, Third Edition (2021)³ summarizes that there were 37 IP regimes under review, out of which 36 were not deemed being harmful, one is considered to be harmful (Jordan). All of them allow the special treatment to patent, 26 offer benefit to copyrighted software and 11 to third allowed category of assets (applicable with SMEs). The tax rates with the special IP regimes varies between 0 % (10 jurisdictions) to 18,75 % in 2020. In the graphs below we present the outcome of the OECD study.

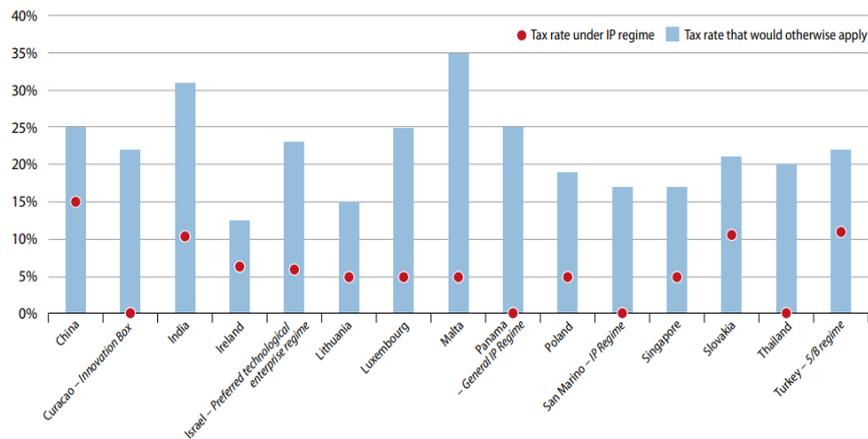


Fig. 2. Reduced rates under non-harmful intellectual property regimes, 2020 (Source: OECD Corporate Tax Statistics: Third Edition, 2021)

³ <https://www.oecd.org/tax/tax-policy/corporate-tax-statistics-third-edition.pdf>

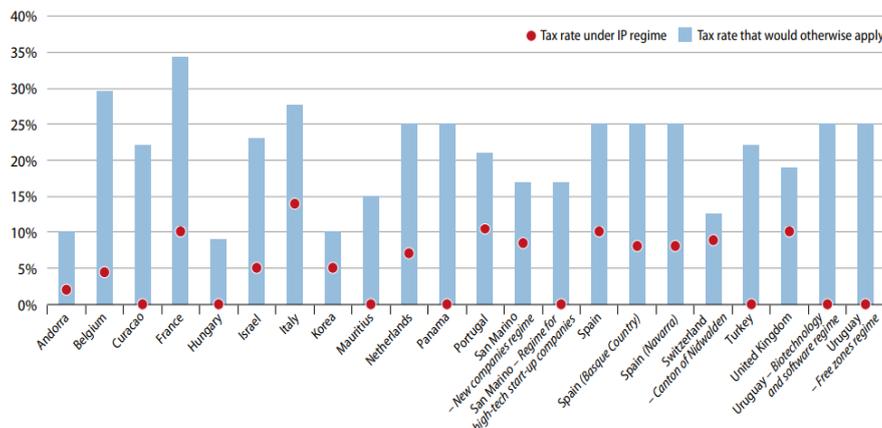


Fig. 3. Reduced rates under non-harmful (amended) intellectual property regimes, 2020 (Source: OECD Corporate Tax Statistics: Third Edition, 2021)

2.2 Slovak context

After the implementation phase of the ATAD and ATAD 2 a new rule which could be favorable for companies in Slovakia was to follow. Patent box has been chosen as a good example, which is widely accepted within the EU, would not harm the common EU market and is in place in many of other European countries. Moreover it supports the R&D which is the future of a prosperous economy (Balco, 2016). This idea was executed via the art. 13a and art. 13b of the SITA, regulating two types of patent boxes: (1) exemption from corporate income tax in the amount of 50 % of the revenues generated from payments for use of patents, utility forms and software and (2) exemption from corporate income tax in the amount 50 % for sale of products, where during the production process patents or utility models have been used.

The first category is more used among the Slovak companies, as it is easier to fulfill. The exemption is meant only for legal persons with seat in Slovakia or for permanent establishments of foreign companies in Slovakia. There are many conditions to be fulfilled as well as many restrictions which reduce the total amount of the exemption to be applied. First of all the patents and utility forms, that generate revenues have to be registered with the respective authority. Software, which has been developed and is subsequently marketed has to be subject to Act on Authors (Strapec, 2018). The restrictions which apply are above all the condition for the IP to be developed by the company on its own (no subcontractors – if so, the amount of the exemptions is diminished according to a formula). The next restriction is in case, if the company is merged or wound-up without liquidation. If there are more companies developing the same IP together, the exemption will be divided between more companies in relation to their R&D cost. Another condition for the patent box in Slovakia is that the R&D cost have to be activated (capitalized) onto the balance sheet. The exemption can be applied during the period of the amortization of the IP. If the R&D cost are capitalized only in

subsequent periods, there is a special formula which decreases the amount of the possible tax exemption.

The exemption under art. 13b is even more difficult to apply. The exemption which also amounts to 50 % of the revenues related to sale of products where patent or utility form has been used, however, those are not 50 % of the total sale price, but the amount of the exemption is determined via a complicated calculation formula which is based on cost accounting calculation of the price of a product. Due to this very complicated method of determination, this kind of exemption was used only by 1 company in Slovakia in 2019. Moreover there are other restrictions with this second form of patent box. The subcontractors restriction and the pro-rata division of patent box is valid also for this second type of the patent box. In addition the merger restriction and the usage of this exemption in case of an additional capitalization of the IP cost are also in place with this kind of tax incentive.

3 Research Design and Methodology

The object of the research is the patent box as regulated in Slovakia as of 1/1/2018. The methodology is the analysis of the drawbacks and difficulties with the application of the regulation in place.

4 Results of the Research

When analyzing the patent box legislation and trying to conclude why so few of Slovak companies make use of it, it is worth to concentrate on restrictions which were introduced with good faith into the legislation, however, make the life and usage of this IP tax incentive very difficult to happen. First it should be noted that the law regulation is quite vague and there is no jurisprudence up to now. Therefore our first result of the research is the uncertainty when applying the patent box in Slovakia, which could cause additional financial burden for Slovak companies if tax authorities may have adverse opinion during the tax inspection in the future (the statutory period in Slovakia for the tax to be levied by tax authorities/for the possibilities of the tax administration to check the use of patent box is 6 years in Slovakia).

Our second result of the research is the difficult application of the art. 13b (second type of the patent box) which requires a very broad and sound revision, due to its administrative difficulty and zero applicability. In your cost calculation you have to prove what was the saving due to the introduction of a patent or a utility form. In the reality this is almost a show-stopper. Our next observation is that the Slovak patent box model is out-of-date, as we accept only invoicing of license fees, whereas nowadays the model like in-app purchase or software as a service is more than common. One of the main obstacles (as analyzed by us) is the condition of the IP capitalization. In countries where this condition is not present, we can observe a wider use of this tax incentive. One of our next observations is the condition of own R&D or the ban of the subcontractors. We understand that this is an OECD-wide condition in order for the

countries to have the patent box accepted in the tax community as not tax harmful. However, the Slovak version is much more severe, whereas we have to stress that it is very common primarily in the IT industry, that the companies do not employ ordinary employees but have freelancers as subcontractors. Therefore our observation and recommendation at the same time would be to loosen this condition in favor of new forms of work arrangements.

Our next result of the analysis is to define more precisely what it means to purchase any IP from a third party. In particular it should be clear if this relates to any kind of purchases, like for consumption material, auxiliary material, auxiliary services, etc. This could be regulated e.g. with a detailed regulation provided by the Ministry of Finance or by the tax administration. Our main finding, however, is the uncertainty connected to two tax areas, which are (1) additional/amending tax returns in connection with tax box and (2) the issue of so-called modernization/upgrade of software. First point is important for companies, when defining the strategy for the future. Let us take an example. The company had not decided to make use of patent box in the past, however after the introduction of a new management they have decided to change the strategy and have made the choice to go back with the tax returns (through additional/amending tax returns) and decided to exempt taxwise their license revenues from the past. There is no clear guidance at the moment, if this approach would be acceptable by the tax administration and thus without any risk for the Slovak companies. As far as the second issue with the upgrades is concerned, we have analyzed the best practices in the IT sector and it is very common, that software is developed continuously and IT firms have cost for development of upgrades/updates. For the moment it is not clear, if the approach to make use of patent box only in case when previously (with the basic software) no patent box had been applied, however now with the amortization of the cost for the upgrades the company decides to make use of the patent box.

5 Discussion and conclusions

It is apparent from our results of the analysis, that the Slovak patent box rules are ambitious, however very restrictive. Therefore it is very rarely used by Slovak companies. It is sad, because the introduction of a “dead law” is just waste of energy and time for all the participants. To make this tax incentive attractive, we recommend first (1) changes/amendments in the SITA and (2) introduction of specific guidelines prepared by the Ministry of Finance or by the tax administration. The concrete amendments and new regulations have been described in the paper under the Results of our research.

We think that it is a very important for the civil servants from the Ministry of Finance or tax administration to closely monitor the use of tax incentives. Because politicians will do it only very rarely. However, after a precise analysis it is then the role of the

politicians to adopt/support new rules which should motivate people to be much more active in the field of R&D in order to make the economy more digital and more environmentally friendly⁴. This is the best way how to stop the so-called middle class income trap which we can be observing in Slovakia in the recent 10 years (Bařo, 2020)

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⁴ Recovery and Resilience Plan for Slovakia, 2021

Electoral Success of ESNS: The Role of Education in the Spatial Context

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Abstract. In this article, we examine the relationship between educational attainment and electoral success of populist radical right party in Slovakia – Ľudová Strana Naše Slovensko. We extend our estimation by taking into account the spatial context of the empirical data, suggesting that political and educational choices are formed early in life in families and communities. Therefore, to estimate how neighborhood influences its residents we are adding in our model spatially lagged explanatory variable referring to higher educational attainment, which represents the weighted average of the neighboring values for this variable. For the purpose of this estimation on the link between educational attainment and voting support for ESNS, we use the results of parliamentary elections held in 2020 on the level of LAU 2. Along with our main explanatory variable relating to university educational attainment, we also include socio-economic and demographic factors as control variables, which were previously empirically proven as statistically significant for the electoral performance of populist radical right parties. Our findings imply that a higher share of residents with university education attainment in neighboring municipalities has an influence on the election results for ESNS in the observed municipality. Residents with university educational attainment are less likely to vote for ESNS.

Keywords: university educational attainment, ESNS, populist radical right parties

JEL classification: D72, R11, R58

1 Introduction

Populist radical right parties (PRRP), favoring populism, anti-immigrant rhetoric, xenophobic views, and Euroscepticism, have recently enjoyed different levels of voting support across the countries of the European Union (Hainsworth, 2008). According to Muller (2016), the rise of PRRP establishes the potential threat, not only to liberal democracy but even to democracy itself. As a reaction to such phenomena and its

further impact, many scholars have tried to estimate potential effects on the electoral success of these parties. According to authors Ivarsflaten & Stubager (2013) there is a certain contradiction in previous studies examining social hierarchy as a variable relevant for the electoral success of PRRP. These authors argue that electorates follow a specific pattern however the major pattern is based on the voter's educational attainment levels rather than their vocational status. Thus, the idea of educational attainment as a determinant influencing PRRP election outcomes is widely held among academics and voting behavior itself.

The link between education and electoral success of PRRP has a long history, dating back to Lipset's usage of it in 1960. Since then, a multitude of possible effects and casual paths has been proposed by scholars in this specific relationship. Most of these studies have empirically proved the plausible hypothesis that lower educated people tend to vote for PRRP. The research of this link has moved further, and scholars have also tried to explain the potential mechanism that could underlay this relationship e.g., why lower educated people tend to vote populist radical right parties. Some of them advocate that higher educated people contrary to lower educated people hold certain social and political values, which leads to their tolerant and libertarian stances. The second one advocates, that people with lower educational attainment are more vulnerable to unpredictably changes in the labor market. Both, we will further discuss in the following section of the literature review.

As was already proved by the empirical findings of a recent analyzes, which concluded the share of votes for LSNS from parliamentary elections, which were held in 2020 of Kuběnková (2021), that lower educated people tended to vote for LSNS in municipalities of Slovakia, we find it necessary to move forward and include in this article also neighborhood effect of university educational attainment. Therefore, the aim of this article is to analyze the influence of university educational attainment of residents living in neighboring municipalities on election outcome for LSNS in the observed municipality. We decided for this approach as consideration of previous findings of Inglehart (1971) who argues that political preferences along with education preferences are shaped early in life in families and local communities. We strongly believe that implementing spatial context will help us to be more precise in our estimation. Moreover, to substantiate this argument, we refer to previous findings of Becker et al. (2017), who identifies that voting patterns resembled geographical patterns of education, along with other socio-economic factors as well as on theoretical and empirical background for education's spillovers. We focus primarily on university educational attainment as it was recognized as a sufficient competitor in the new global economy, and it is crucial for regional development rather than primary or secondary education (Faggian & McCann, 2013). Similarly, we believe that this approach could reflect on the current gap in the literature of spatial distribution of educational attainment and its further effects. Moreover, we are certain that Slovakia can create a compelling picture, as it is one of the few places where the PRRP's glory has been shattered and resurrected several times (Mudde, 2007). Nonetheless, voter support for PRRP appears to have been constant since 2016, with the unexpectedly successful

election of LSNS to the national parliament. The LSNS, a neo-Nazi-affiliated party, was re-elected in 2020, ending fourth with 17 seats in parliament. Another factor for Slovakia's selection is the lack of literature on PRRP in the CEE area. This research gap is remarkable, given the emergence of PRRP and democratic backsliding in CEE countries.

For this purpose, in this article, we use regression models including a spatially lagged explanatory variable for the testing neighbouring influence of higher educational attainment level, along with control variables, on LSNS's electoral success in the LAU 2 regions of Slovakia. The spatially lagged explanatory variables allow us to consider the values observed at neighbouring locations, more precisely, the spatial lag is a weighted sum of the values observed at neighbouring locations, since the non-neighbours are not included (Anselin, L., Rey, S. J. 2014).

1.1 Literature review

In this article, we define populist radical right parties in with accordance Mudde's definition (2007), who interpret PRRP as political parties with a core ideology that is a combination of nativism, authoritarianism, and populism. While nativism is an ideology, which holds that states should be inhabited exclusively by members of the native group and that nonnative elements are fundamentally threatening to the homogenous group. Authoritarianism refers to the belief in a strictly ordered society. Populism is understood as a thin-centered ideology that considers society to be ultimately divided into two homogenous and antagonistic groups – the pure people versus, the corrupted elite”, arguing that politics should be the *volonté generale* of the people.

Education is one of the factors concerned, and it is also one of the most common components in models aimed at eliciting support for populist radical right parties (PRRP). Based on the previous research, conceivable hypothesis is that people with lower educational attainment are overrepresented within the voter base of populist radical right parties (Ivarslafte and Stubager, 2013). In the literature are presented more than two plausible processes that might explain the link between educational attainment and PRRP's electoral performance. According to first group of scholars Education aids in cognitive development that allow individuals to be more attentive and respectful to different cultures (Lipset, 1960). Others have suggested the possibility of students being socialized into specific libertarian political beliefs and norms at a higher education institution. Education, according to the latter set of experts, has an influence on political choices since it is linked to an individual's material circumstances. Based on this presumption it is believed that education is one of many possible factors, that preserve and regrow socio-economic disparities within society. These authors also emphasize the indirect impact of education – highly educated people might have a higher social standing inside the social structure. Hence, persons with a lower level of education may be more sensitive to risks posed by globalization and the economic crisis (Inglehart & Norris, 2016). These possible impacts of educational attainment on PRRP

were separated into two linkages by the authors Ivarslafte and Stubager (2013). The first argument implies that there is a link between education and material status, implying that PRRP would perform better in tough economic times and in geographically disadvantaged areas. The latter one is referring to link between education and values, as well as how individuals with and without higher education respond differently to immigration, immigrant-origin minorities, and ethnic diversity.

Human capital externalities are considered, based on the theoretical and empirical literature, as the main engine of economic growth while including different potential mechanisms (Hanushek & Woessmann, 2020). One of the possible views suggests that education not only enhances productivity of the educated person, but also the productivity of his co-workers (Hanushek, 2002). On the other hand, some of the authors argue for another category of education spillovers where education can increase civic engagement, which results in the creation of a stable and democratic society. Moretti (2003) more precisely argues that better-educated citizens create an externality, that may benefit all citizens. Better educated citizens can be more informed voters and they can also process a given amount of information more reasonably due to cognitive skills improvement provided by education.

Following the surprising victory of the LSNS to the National Slovak parliament in 2016 and re-election in 2020, PRRP's electoral success in Slovakia has remained constant. Unpredictable fluctuations in voter support for PRRP in Slovakia have piqued the interest of a few academics, who analyse the possible repercussions of this support. For example, Reháč et al. (2021) concluded while comparing electoral success of traditional extreme right party (SNS) and the new radical right party in Slovakia (LSNS) that support for SNS is based on nationalistic and cultural factors while LSNS has achieved their success due to regional economic factors such as wages and unemployment rates. In the context of education, their empirical findings imply that LSNS had worse electoral performance in the municipalities with a higher proportion of citizens with a university degree. Likewise, Voda et al., (2021) discussed in their study unexpected electoral success of LSNS in 2016 while adding that LSNS was successful in economically disadvantaged areas with lower purchasing power. According to their findings, the effect of vocational education played a significant role in the election year 2016, compared to 2010 and 2012. Both studies analyzed the electoral performance of LSNS in the national parliamentary elections that took place in 2016 and years before. Regarding the educational attainment Kuběnková (2021) has observed that lower educated people were likely to vote for LSNS in the national parliamentary elections of 2020.

Following the above, we developed our hypothesis based on the presented theories and the current gap in the literature neighbourhood effects. We assume that the influence of educational attainment on voting for LSNS is not a spatially isolated

process but is also determined by the level of educational attainment in neighbouring municipalities.

H1: Higher share of residents with university educational attainment in neighbouring municipalities has an influence on the election results for LSNS in the observed municipality.

2 Material and Methods

In this article, we identify LSNS as a Populist Radical Right Party. We classified this party as a PRRP based on the results of the Chapel Hill 2020 Expert Survey, where all the above characteristics indicate that SNS is not just a radical right party, but also a populist one (high ranks in anti-establishment salience, position on people vs elected representatives). Second, we needed to collect data for our dependent and independent variables from multiple sources. For our independent variable – education, we considered the highest educational attainment – university education. The independent variable– level of educational attainment was used for calculation with a neighbor structure defined by the non-zero elements of the spatial weight matrix W (in our case we used distance weight using K-Nearest neighbors K=6). Lastly, we decided to run regression models (1-2) with including spatially lagged variable and socio-economic and demographic variables, which we consider as the most suitable for our empirical analyses.

To test our hypothesis, we collected data aggregate on the level LAU 2 for our dependent variable – share of votes for LSNS obtained in the parliamentary election in 2020. Data were gathered from Statistical Office of the Slovak republic (ŠÚSR). Independent variables – *shighedu*, *srelig*, *sminor* were aggregated on the level LAU 2. We collected them from Population and Housing Census in 2011. Other independent variables – *unemployr*, *density*, *distreg_km*, *sprop2029*, *vt2020* were gathered from ŠÚSR. Variable referring to the share of people with higher educational attainment is *shighedu* (higher education). Contrary to it we created spatial lagged explanatory variable (*slv_highedu*), which represent the weighted average of the neighboring values for the variable *highedu*. *sMinor* represents the share of population belonging to the national minority, *srelig* represents the share of the religious population, *unemployr* represents average unemployment rates calculated between 2016 and 2020, *density* represents the density of municipality, *distreg_km* represents the municipality distance from the capital city of the region, *sprop2029* is the share of the population with an age 20-29, *vt2020* refers to turnout in the parliamentary elections in 2020. Descriptive statistics for used variables in our model can be seen in Table 1.

Table 1. Descriptive statistics

VARIABLE	LEVEL	OBS	MIN	MAX	MEDIAN	MEAN	STD. DEV.
LSNS	LAU 2	2926	0	52.632	9.176	9.718	5.581

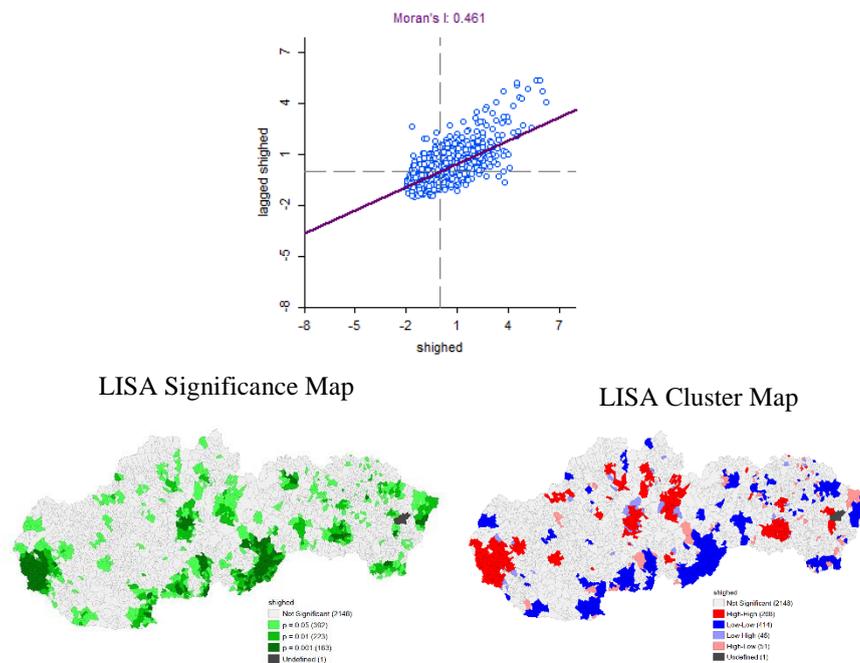
shighedu	LAU 2	2926	0	35.937	7.825	8.466	4.377
slv_highedu	LAU 2	2926	1.923	32.131	8.070	8.422	3.167
srelig	LAU 2	2926	26.829	100	88,615	86,006	10.650
sminor	LAU 2	2926	0	99.052	1.887	16.461	27.168
unemployr	LAU 1	2926	2.63	18,92	6.66	8.315	4.459
density	LAU 2	2926	-0.347	4.132	1.770	1.762	0.443
distreg_km	LAU 2	2926	0	93.986	35.792	38.704	20.927
spop2029	LAU 2	2926	0	44.444	13.667	13.852	2.748
vt2020	LAU 2	2926	8.977	98.544	67.038	65.310	10.086

Source: author, based on data from ŠÚSR and Population and Housing Census in 2011

3 Results and Discussion

Spatially lagged variables are variables that consider the values observed at neighboring locations, in our case municipalities. They are created on the basis of spatial weights, which are used for the construction of tests for spatial autocorrelation (Anselin, L., Rey, S. J. 2014). As we assume, based on the theories presented in the Literature review, that we might deal with spatial autocorrelation we can firstly use Moran's I and visualize our data for higher education and test for the presence of differences across regions. For this purpose, we will use the local variant of Moran's I, which is also known as the Local Indicator of Spatial Association (LISA). It denotes the geographic clustering of comparable values in the vicinity of the observations (Anselin, L., Rey, S. J. 2014). Scatter plot of Moran's I in Figure 1 indicates that its number is approaching 1, which means that within municipalities is positive spatial autocorrelation. This can be interpreted as follows - if the resident of the municipality achieved higher educational attainment, then the resident from the neighboring municipality achieved higher educational attainment as well. According to LISA Cluster Map, we can see that municipalities with the similar values of share of residents with higher educational attainment (red, high-high; blue, low-low) are distributed across the country, but mostly in the municipalities located in the south of Central Slovakia and West Slovakia, where this relationship can be approved with LISA Significance Map on the level of $p=0.01$.

Figure 1: Univariate local Moran's I for higher educational attainment in Slovak municipalities



Source: author, based on data from ŠÚSR

The results of our estimations including spatially lagged variable are presented in Table 2. Results of our first model (Model 1) show a negative relationship between higher education and vote for ESNS. A higher share of people with university educational attainment leads to lower voting support for ESNS in the municipality. The effect of education is the strongest in the municipalities where is a higher share of individuals with a university degree, which results in the decline of voter's support for ESNS about 0,335 percentage point. To decide whether we can accept or reject our alternative hypothesis implying that educational attainment in neighboring municipalities influences the election results for ESNS in observed municipalities we have to interpret the results from Model 2. Based on Model 2, where we included spatially lagged variable ($slv_highedu$) in order to control neighborhood effect, we can accept our alternative hypothesis as the statistical significance of variable ($highedu$) corresponds with spatially lagged variable ($slv_highedu$). These results prove that the influence of educational attainment on voting for ESNS is not a spatially isolated process but is also determined by the level of educational attainment in neighboring municipalities. While including spatially lagged variable as a control for neighborhood effect, we can observe in Model 2 decline in the effect of higher education ($\beta = -0,287$)

on voting support for LSNS, but on the other hand, there is a slight increase in adjusted R-squared implies that including spatially lagged variable added a value to our model.

Table 2. – Regression models with spatially lagged variable (1) - (2)

	Model 1	Model 2
highedu	-0,335*** (0,025)	-0,287*** (0,028)
slv_highedu		-0,159*** (0,038)
relig	-0.066*** (0.009)	-0.071*** (0.009)
minor	-0.124*** (0.003)	-0.125*** (0.004)
unemployr	0.064* (0.024)	0.058* (0.023)
density	-1,620*** (0.219)	-1.487*** (0.220)
distreg_km	0.026*** (0.005)	0.021*** (0.005)
pop2029	0.101** (0,033)	0.096** (0.032)
vt2020	-0.003 (0.011)	-0.002 (0.011)
cons	20.395	21.49
N	2926	2926
adj. R-sq	0.368	0.372

Source: author, based on data from ŠÚSR and Population and Housing Census in 2011

The results of socio-economic and demographic factors are in accordance with empirical findings of Reháč et. al (2021). As a result, a greater religious population, as well as a bigger percentage of minorities residing in rural areas and a higher population density, leads in lower voter support for LSNS. On the other side, more voter support for SNS is attributed to a larger population between the ages of 20 and 29, higher average unemployment rates, and a greater distance from the capital city of certain municipalities. The turnout in parliamentary elections in 2020 came out as non-significant.

We tried to test one of the possible mechanisms, that underlies the effect of education on political preferences suggesting that it is connected to material position. We referred to Inglehart (1971), who argues that political preferences along with education preferences are formed in early life in families and local communities and to Becker et al. (2017) who identifies that voting patterns resembled with geographical patterns of education. Moreover, from the theories on spillovers from education we referred to

some of the authors suggesting that educated voters engage more in civic engagement and can make more informed choices, which both lead to benefit for whole society. By including spatial context more precisely spatially lagged variable, we were able to prove our alternative hypothesis in Model 2 where figured the variable referring to higher (university) educational attainment. Therefore, it seems that there is an educational interaction within some municipalities based on the results from LISA analysis, but also based on the results from the regression. Higher share of residents with university educational attainment in neighbouring municipalities has influence on the election result for LSNS in observed municipality, as was proved by the corresponding significance of explanatory variable with its given spatially lagged explanatory variable. Overall, LSNS did better in municipalities with a higher average unemployment rate and would be in the accordance of argument suggesting that PRRP will gain higher popularity in the regions that are economically deprived.

4 Conclusion

The rising popularity of PRRP is now a widespread phenomenon in European democracies, and Slovakia is no exception (Hainsworth, 2008). Ivarsflaten & Stubager (2013) point out that their findings contradict prior research that looked at social structure as a factor in populist extreme right party electoral success. According to these scholars, electorates follow a particular pattern, however, the main pattern is not observed in the voter's occupational position but rather in their educational attainment levels. One of the possible mechanisms was introduced by Inglehart (1971) suggesting that political preferences along with education preferences are formed in early life in families and local communities and by Becker et al. (2017) who identifies that voting patterns resembled geographical patterns of education. Theories on human capital spillovers suggest, that educated individuals could create benefits for the whole society by increased civic engagement and reasonable choice of political candidates, which leads to a stable and democratic society (Moretti, 2003). Based on these arguments, we tried to move our analysis further and estimate the influence of educational attainment on the electoral success of LSNS including the spatial context and for this purpose, we used spatially lagged variable. The results of Model 1 showed that higher educated people are less likely to support LSNS. The neighborhood effect seems to be important in Model 2, where the significance level of the variable corresponds with the significance level of the spatially lagged variable. This implies that the influence of educational attainment on voting for LSNS is not a spatially isolated process but is also determined by the level of educational attainment in neighboring municipalities in the case of higher education. Our empirical findings prove that a higher share of residents with university educational attainment in neighboring municipalities has an influence on the election results for LSNS in the observed municipality. This might be an important implication for public politics, as it seems that higher education does not only lead to lower support for populist radical right parties in specific municipality but might has influence on the other municipalities as well and vice versa. However, our approach is limited, as it is necessary to empirically test other factors that may influence LSNS

electoral success, such as interethnic contact, associational involvement, social trust, Euroscepticism, perception of ethnic threat, nationalism, and authoritarianism, as proposed by Ivarsflaten & Stubager (2013). This leaves a room for further research.

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How the Covid-19 Pandemic Influences Risk Tolerance Over Lifetime

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Abstract. An individual's attitude to risk is relatively stable throughout one's lifetime, but individual risk tolerance changes over time. How much it changes regarding financial decision-making primarily depends on individual risk preferences, but can also be influenced by exogenous shocks like a pandemic. The ongoing Covid-19 pandemic is a good example: It has created a tremendous uncertainty globally, resulting in, e. g., emotional reactions at the stock market, many missed job opportunities in the labor market, and many damaged business opportunities.

Keywords: Risk Tolerance, Covid-19, Behavioral Economics

JEL classification: E 71, D 91

1 Introduction

A major global crisis—by definition a temporary, unpredictable and unstable situation—like the ongoing Covid-19 pandemic can have a negative impact on the functioning of the economy [11]. This includes, but is not limited to a decline of investments, unstable stock markets, and unemployment rise. Such a crisis can change our tolerance of risk preferences. It can evoke feelings of uncertainty on an individual level influencing the decision making on fundamental life issues such as investments, job change, or business activities.

According to relevant literature, it has been proven that people actively make use of life experiences for future decision-making, and that economic crises and downturns generally result in an increase of individual risk tolerance [7]. Malmendiar and Nagel

(2011) conclude people who experienced the financial crisis of 2008 can feel unpleasant in financial decision-making for several decades.

This paper considers data from key long-term studies on individual financial risk tolerance and first studies on the impact of the Covid-19 pandemic measured through hypothetical economic game experiments. These first studies on the impact of the Covid-19 pandemic only show minor changes if any in individual financial risk tolerance.

This paper aims to analyze the impact of the Covid-19 pandemic on individual financial risk tolerance based on the results of recent and long-term hypothetical game experiments. It argues that the Covid-19 pandemic will have a measurable significant influence in the mid- and long-term, because, as long-term studies have proven, traumatic events and defining experiences generally have a lasting influence on risk taking.

2 Review of Relevant Literature

There is a number of studies primarily focusing on changes in risk preferences (e.g. Barsky, Juster, Kimball, Shapiro, 1997; Hui, Sherman 1998; Kimbal, Sahm, Shapiro, 2008; Dohmen, Falc 2011). Most of these studies find heterogeneity by individuals' perception of risk. They find a correlation between risk preferences and demographic factors like age or gender. Generally, men are more risk tolerant than women (Dohmen et al., 2006, 2011; Falk et al., 2018), and younger more than older people (Barsky, 1997; Sahm, 2007). However, this has also been proven by these and many other studies, risk preferences are generally not affected by economic or social circumstances.

This paper is based on the assumption that "the stability of risk preferences implies that, in the absence of measurement error, one should observe the same willingness to take a risk when measuring an individual's risk preferences repeatedly over time" [17]. Alexy et al (2016) tested in their experiment consistency of depicted risk attitudes in three different measurement procedures, two uniparametric and one multidimensional. They did not find association in uniparametrics procedures [1]. Empiric studies confirm low correlation related to macroeconomic factors like exogenous shocks or financial crises. Cohn et al. (2013) uses a laboratory experiment to measure risk tolerance during economic downturn. They indicate "fear is a plausible explanation for why risk aversion is higher during a bust than a boom" [4].

Usually, stability of risk preference is measured on individuals. In order to quantify the stability level of risk preferences of individuals throughout lifetime, panel data from long-term research studies are used. For example, Sahm (2007) used panel data from hypothetical gambles on lifetime income conducted with more than 12,000 individual participants over a period of 10 years. She identified a modest decline (1.7% each year, in total 20%) of risk tolerance among the group of older adults aged 45-70. These results correspond with the findings of other, similar studies.

Human capital is chosen as a reference variable, because it significantly affects relative risk aversion. Barsky (1997) found substantial heterogeneity in estimates of risk

preference. While most respondents of his experiment incline to undertake substantial gambles over lifetime income, i. e., most of the population are characterized as low risk tolerant, strongly increased risk-tolerant behavior by individuals is rare [3]. Hence, this finding suggests an increase of risk aversion after the Covid-19 pandemic in the mid- and long-term.

During the ongoing Covid-19 pandemic, most studies that measured risk tolerance through hypothetical economic game experiments, as usual, compared the influence of demographic factors on risk tolerance. Many economic experiments were repeated in several waves before and during the pandemic, allowing to measure the stability of risk preferences over time. The results of these studies are consistent with findings of previous studies conducted before the pandemic regarding the influence of demographic factors (see, e. g., Fan et al., 2020).

The economic experiment of Drichoutis and Nayga (2020) repeatedly measured risk and time preferences in three waves in 2017, 2019 and 2020 (about 1,000 respondents across all waves). The study participants were undergraduate students from Greece, but only the experiments in 2019 and 2020 were realized with the same participants. This allows conclusions on individual stability of risk preferences, and they found no statistically significant changes. The last wave was completed by the end of the first lockdown in March 2020. The results did not find any statistically significant differences in risk preferences, i. e., the pandemic generally had not affected the participants' risk preferences [6]. Angrisiani et al. (2020) came to similar results. They conducted a two-wave economic experiment with students and professional traders from England in 2019 and 2020. In general, the risk preferences of these sample students and traders remained stable and did not show a change in risk appetite. However, there were minor, but statistically significant changes on the individual level: when asked, participants who went through a Covid-19 infection themselves or experienced infection cases in their private sphere generally showed a measurable increase in their risk preferences.

However, a few studies already show broader measurable impacts of the Covid-19 pandemic on decision-making under risk, e. g., the study of Harrison et al. (2020) in the United States. It used a six-wave online experiment with students between May and October 2020. This study found an instability in atemporal risk preferences in comparison to similar studies conducted before the pandemic. A majority of the participants from previous studies inclined to risk neutral choices, while participants of this study showed an increase in risk aversion [10]. Also Guenther et al. (2021) measured changes in risk tolerance in an experiment with students in the United Kingdom during the first months of the pandemic last year. While men showed a higher than average risk tolerance than women, it still decreased in both sexes with age [9]. Another study from Wuhan shows that participants who remained in Wuhan during the lockdown in 2019/20 exhibit lower trust, cooperation and increased risk tolerance in relation to participants of similar, previous studies [18]. These studies show first signs how the Covid-19 pandemic influences economic preferences and behavior.

3 Methodology

This paper is inspired by studies that measured long-term risk tolerance preferences (Barsky, 1997; Sahm, 2007). They quantified the approach to financial risk using the utility function in lifetime income games. The results confirm the theory about stability of risk preference by individuals over life time span. The research of Sahm relates to results of older adults aged 40-75. This study includes hypothetical gambles on lifetime income from the U.S. Health and Retirement Study (HRS). HRS collected data from individuals over a period of 10 years, which was used to quantify individuals' risk preferences. The results suggest that “less than 30% of the systematic variation in risk tolerance—for this sample of older adults in the 1990s—is associated with time-varying attributes” [15].

For this study, we are using further research to analyze the influence of exogenous shocks on financial decision making. Economic instability and crises, triggered, e. g., by war, climate changes or a pandemic, influence our financial decisions under risk and change individual risk preferences in the mid- and long-term.

Table 1. Responses to Lifetime Income Gambles [13]

Response Category	% by HRS Survey Wave				
	1992	1994	1998	2000	2002
1		44.4	39.5	45.0	43.2
2	64.7	17.2	18.7	19.4	18.8
3	11.9	13.8	16.2	14.6	15.6
4	10.9	15.0	9.4	8.6	9.9
5		5.9	9.1	6.8	6.5
6	12.5	3.7	7.1	5.6	6.0
Responses	9,647	594	2,502	943	4,939

Table 1 shows how different individual levels of risk tolerance can be based on HRS data. Depending on the accepted level of risk by hypothetical game, the participants were assigned to one of six categories. The first two category included participants who could choose a low risk of loss, even when the expected value of gamble is substantially larger. In 1992 and 1994, almost two-thirds of the respondents decided for this category. The sample of respondents in those years included individuals born between 1931 and 1947. In order to quantify the approach to risk, the respondents were divided in two groups, on the one hand those who were born between 1931 and 1936 and on the other hand those born between 1937 and 1941. The first group was 16% less willing to take a risk, i. e., the respondents born closer to the Great Depression behaved more risk averse. Table 1 also shows the stability of gamble response across waves. Only the respondents of 1998 were willing to accept a somewhat higher income risk.

Another analysis of 693 respondents (see Table 2), who participated in the gamble in both HRS waves in 1992 and 1994, allows to compare and quantify the stability of individual preferences between two waves by the same respondents. “The correlation

of the response categories across the two waves was 0,27 and almost half switch response categories” [13]. The results show how unstable the decision-making preferences are.

Table 2. Age, Cohort and Time [13]

Latent Variable: Log of Risk Tolerance				
Parameter	Alternate Specifications of Time Effects			
Age	-0.017 0.008	-0.16 (0.09) (0.00)	-0.021 0.010	-0.021 0.010
1937-1941 Cohorts	0.16 (0.06)	0.17 (0.07)	0.14 (0.07)	0.14 (0.07)
1942-1947 Cohorts	0.16 (0.10)	0.16 (0.11)	0.10 (0.12)	0.10 (0.12)
Consumer Sentiment	0.009 (0.002)	0.006 (0.003)		0.007 (0.004)
ICS Six Months Ago		0.004 (0.003)		
ICS One Year Ago		-0.001 (0.003)		
1994 HRS			0.27 (0.08)	0.19 (0.09)
1998 HRS			0.37 (0.08)	0.19 (0.11)
2000 HRS			0.32 (0.11)	0.12 (0.14)
2002 HRS			0.24 (0.11)	0.17 (0.11)
Log-likelihood	-23573.5	-23571.5	-23571.2	-23569.0
Parameters	55	59	59	61

The first column of Table 2 illustrates how the level of risk tolerance changes over life time span. The results show an average reduction of willingness to take risks by 1.7 % each year. The second column contains the data about macroeconomic effects with a help of consumer sentiment. The results suggest the association between a macroeconomic condition and risk tolerance is only strong at the beginning. Initially, a it has an association of 0.006 (t-statistic of 2.2). After 6 months it declines to 0.004 (t-statistic of 1.6), and after one year to -0.001 (t-statistic -0.4). These results indicate why current studies only show minor changes if any in individual financial risk tolerance, because the Covid-19 pandemic has begun about one and a half years ago.

Table 3. Elicited Risk Preferences across Treatments [2].

	Pre-Covid Treatment			COVID Treatment			$H_0 : \Delta BRET = 0$
	Mean	SD	Med	Mean	SD	Med	p-value
All ($N = 108$)	46.35	14.32	50.00	48.00	15.26	50.00	0.32
Traders ($N = 48$)	50.25	12.40	50.00	53.38	14.97	50.00	0.17
Students ($N = 60$)	43.23	15.07	43.50	43.70	14.19	46.00	0.85

Agrisani et al. (2020) used “median and standard deviation of the BRET, which remain over time constant” [2], in order to quantify risk by individuals (BRET stands for Bomb Risk Elicitation Task; see Crosetto and Filippin, 2013 [5]). They conducted a two-wave economic experiment with students and professional traders from England in 2019 and 2020. The first wave took place before, the second wave at the beginning of the Covid-19 pandemic. 60 students and 48 traders participated in both rounds. The average age of the students was 21, of the traders 34. The majority of participants was male. The first experiment was conducted in the first quarter of 2019, the second part in April 2020, when the United Kingdom and many other countries were in a hard lockdown. This paper analyzes what changes may occur in the perception of risk triggered by the Covid-19 pandemic. According to previous literature, the kind of uncertainty we are experiencing during the ongoing pandemic can change individual risk tolerance. Stress, fear, or cognitive load induce elevated levels of risk aversion. Although the results from Agrisani et al.’s (2020) t-test measuring risk aversion across periods of pre-Covid-19 and Covid-19 time find no treatment effect, as was fail to reject the null hypothesis, the last columns of Table 3 provide BRET choices between pre-Covid-19 and Covid-19 treatment (p-value for whole sample was 0.32, for traders 0.17 and for students 0.85). Those, who did not change their preference, incline to be moderately or severely worried about the pandemic. Respondents with worries stayed approximately 20% more at the previous decision from pre-Covid-19 time than the other groups. This result is significant at the 5% level (Table 4) [2]. Also participants who had a close relative, friend or colleague diagnosed with Covid-19, or had Covid-19 themselves, increased their risk tolerance by a significant coefficient of 1%.

Table 4. Changes in Risk Preferences across Treatments [2]¹

	Decrease	No Change	Increase
High Impact on Current Finances	0.003 (0.103)	-0.101 (0.104)	0.098 (0.118)
High Impact on Future Finances	-0.006 (0.082)	-0.010 (0.078)	0.016 (0.099)
High Activity Disruption	0.136 (0.088)	-0.019 (0.084)	-0.117 (0.088)
Worried about Pandemic	-0.047 (0.089)	0.188** (0.092)	-0.140 (0.096)
Diagnosed Own - Yes	0.064 (0.223)	0.240 (0.263)	-0.304*** (0.107)
Diagnosed Others - Yes	0.113 (0.120)	0.169 (0.106)	-0.282*** (0.083)

The negative experiences with Covid-19 caused changes in behavior and participants inclined to choices with less risk. The study was able to quantify influence of traumatic events and confirmed influence of emotions. Changes in income or wealth were excluded.

¹ Method standard errors in parentheses. *: p - value < 0:1, **: p - value < 0:05, ***: p - value < 0:01.

4 Results & Conclusion

Risk preferences change over the lifetime. Individuals become more risk averse year by year over lifetime. Some research showed that the willingness to take risks is higher by young people than adults; this applies to both sexes. Several scholars have researched how risk tolerance changes with advanced age and macroeconomic conditions (Barsky, 1997; Sahm, 2007). Economic crises and downturns resulted in an increased risk aversion, possibly reducing self-employment and investments in stocks, which in turn can amplify macroeconomic downturns (Schildberg-Hörisch, 2018). Stability of preferences change over lifetime and influence financial decision-making. However, if lasting preferences are correlated with time or financial risk, fundamental changes may occur in the results. Research confirms non-stability of risk preferences over time. The value of life experiences must also be taken under consideration in decision-making. According to the literature the current Covid-19 situation influences the risk tolerance for financial decision-making. Figure 1 illustrates the stability of risk preferences during lifetime. The solid line shows the standard course of risk preferences, related to empirical results about decreasing risk preferences with advancing age. Exogenous shocks can rapidly affect the level of risk tolerance (see the dashed line). Temporary variation of risk preferences can be evoked by emotions, self-control, or stress. It represents only temporary deviation.

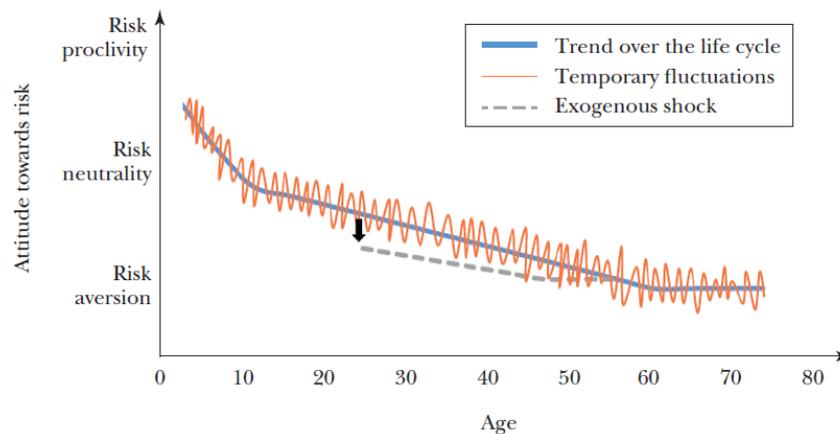


Fig. 1. Illustration of Framework for Studying the Stability of Risk Preferences [16].

Exogenous shocks such as natural disasters, violent conflict, or financial crises affect risk preferences. The research of Hanna and Wang (1997) included people born before 1929, when the stock market crashed. The memories of the Great Depression affected their risk perception, i. e. they had a higher risk aversion in comparison to the people born in times of economic stability. Similarly, the ongoing Covid-19 pandemic has the

potential to change the willingness to take financial risks of a whole generation. Financial crises reduce risk-taking of investors in the stock markets. Uncertainty in the labor market can cause irrational behavior of individuals. The study of Sahn (2007) suggests that changes in income or wealth are unrelated with financial crises.

Further papers have addressed the impact of economic crises in relation to risk perception. Research by Guiso, Sapienza and Zingales (2013) confirmed, that the financial crisis of 2008 affected the risk tolerance of Italian bank clients. Compared to the pre-financial crisis period the risk tolerance of the bank clients had increased [8]. Empirical studies have shown how traumatic events can affect risk appetite. In times of uncertainty, individuals reconsider their behavior which is reflected in increased risk aversion. Our savings, investments, or pension depend on individual decisions. From the willingness of individuals to take risks predictions can be made regarding health issues, job change, habits, or financial behavior [13]. Although the study of Guiso et. al. (2013) confirmed an impact of the financial crisis on decision-making, it was not able to explain how big it actually was.

Since the Covid-19 pandemic is still ongoing, the mid- and long-term effects on individual financial decision-making cannot yet be analyzed, but they can—as outlined in this paper—be predicted based on previous long-term studies that included participants who experienced major exogenous shocks in the past like the Great Depression. In order to get a solid data basis for the future, ongoing long-term studies on individual financial risk tolerance measured through hypothetical economic game experiments need to be continued. Now is also a good time to launch new long-term studies in this field, also in Slovakia.

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The Impact of Automation on Employment Growth in Slovakia¹

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Abstract. The aim of the paper is to examine the relationship between employment growth and automation probabilities (substitution potentials) for occupations in Slovakia. We use detailed employment data provided by Trexima Bratislava, automation probabilities by Frey and Osborne (2017) and substitution potentials by Dengler and Matthes (2018). The results show that between 2014 and 2019, there was an overall increase in employment on the Slovak labor market. However, occupations at a higher risk of automation experienced lower employment growth during the examined period. Even though these results are confirmed by regression analysis, the aim is not to provide any causal interpretation, since the risk of automation (substitution potential) is not the only explanatory factor for the employment growth in Slovakia.

Keywords: Automation, Employment Growth, Slovakia

JEL classification: *J21, O33*

1 Introduction

Recent advances in automation technologies and digitalization are expected to increase productivity and social welfare. On the contrary, new technologies replace human labor in tasks usually considered as the main domain of human activity and there is increasing anxiety related to technologies that may become a threat to humans, labor, employability, and related socio-economic consequences.

According to the newest research, for instance, by Georgieff and Milanez (2021), there has been no support for net job destruction at the broad country level so far. Therefore, we examine the relationship between employment growth and automation probabilities (substitution potentials) in Slovakia. The aim of the paper is to identify,

¹ The paper is a part of the research project VEGA 1/0781/21: Priemyselná politika v podmienkach deindustrializácie a automatizácie.

whether employment increased or decreased between 2014 and 2019 and if the growth has been higher or lower in occupations with a higher risk of automation. We use detailed employment data provided by Trexima Bratislava, automation probabilities by Frey and Osborne (2017) and substitution potentials by Dengler and Matthes (2018). Based on the analysis, it seems that employment growth is lower with an increasing risk of automation (an overall increase of 11% versus 9% and 4% in occupations at the highest risk of automation based on the taken approach).

The paper proceeds as follows. The first section includes a literature review on the predicted impacts of automation on the national economies. Next, we present the methodology and data used together with the main empirical results. The results cover employment growth between 2014 and 2019 in Slovakia, together with the relationship between this growth and occupations with different automation risks. An understanding of automation's impacts can form a basis for policymakers for targeting scarce public resources on those most in need. The last section concludes.

2 Literature Review

The vision of a fully automated and integrated production process from the very beginning up until the distribution of products is no longer a far-off dream, which raises questions and concerns about future work. Autor et al. (2003) and Autor and Dorn (2013) claim that computerization has been affecting mostly routine tasks, however, Frey and Osborne (2017), McAfee and Brynjolfsson (2018), and many others suspect that current technological changes may allow computers and machines to substitute an increasing amount of non-routine tasks, as well. The literature already provides an extensive list of estimates assessing the liability of jobs or particular tasks to potential technological disruptions. For instance, Frey and Osborne (2017) examined the current jobs susceptibility to technological developments. They used new methods to predict computerization probabilities for 702 occupations and distinguished between high-, medium-, and low-risk occupations regarding their automation probabilities. As the aforementioned authors emphasize, their main aim is not to estimate the number of jobs being automated, but to focus on the potential automatability of jobs over the next period. They claim that a relatively high percentage of U.S. jobs faces a high risk of computerization, 47% to be precise.

Based on the above-mentioned study by Frey and Osborne (2017), some authors were inspired by their approach and used either an *occupation-based* or a *task-based* approach to predict the jobs automation risk in other economies. Using the occupation-based approach, Pajarinen and Rouvinen (2014) showed that the share of jobs exposed to automation is about 35% in Finland while other authors – Brzeski and Burk (2015) – estimated that 59 % of jobs in Germany are considered to be at a high risk of automation. Using more aggregated employment data, Bowles (2014) finds that the share of jobs highly exposed to automation in Europe is between 45% to 60%, with the highest susceptibility in southern Europe. Also, the paper shows that roughly 55% of jobs are at a significant risk of automation in Slovakia. This estimate is in line with the EU member states' average of 54%.

Using a task-based approach offers much lower susceptibility to automation in comparison with an occupation-based approach (Arntz et al., 2016). This group of authors shows that when allowing for the heterogeneity of workplace, the automation risk of jobs drops to 9 % in the United States. Their study for 21 OECD countries provides several results – on average 9% of jobs are highly automatable, the lowest risk of automation is faced by the workers in South Korea (6%), the highest risk is in Austria (12%), while the share for Slovakia accounts for 11%. Also, this paper from 2016 indicates that the highest risk of automation is shared by the low-income population and employees with primary and lower secondary education. When it comes to the labor market in Slovakia, it can be found in fourth place in terms of risk, following countries like Austria, Germany or Spain. Nedelkoska and Quintini (2018) used a very similar method, when they extended the analysis to 32 OECD countries and estimated that the average share of jobs at a high risk of automation is close to 14%. Looking at the country level, the shares range from 6% to 33% and Slovakia was the economy with the highest risk of automation. The average job automatability in Slovakia equal to 57%. Pouliakas (2018) reached the same results for EU countries as Nedelkoska and Quintini (2018) that 14% of a European working age population (from 24 to 65 years of age) are confronted with a high risk of automation.

On the contrary, Dengler and Matthes (2018) used their own expert estimates of the automation risk faced by individual occupations in Germany. According to these authors, compared to the 47% in the case of using the occupation-based approach, the share using the task-based approach is significantly lower, particularly 15% of German employment has to face a high automation risk. They belong to one of the first scientists who confirmed the relationship between probabilities of automation and employment growth. They found that between 2013 and 2016 employment was growing slower with increasing substitution potential of certain occupation. Nonetheless, substitution potentials do not belong to the only explanatory factor for employment growth.

Mihaylov and Tijdens (2019) have chosen a similar approach consisting of the analysis of the task content of the individual occupations in the ISCO-08 (International Standard Classification of Occupations). They categorize the tasks into the following groups – non-routine analytic, non-routine interactive, routine cognitive, routine manual and non-routine manual – and then predict the share of employment at a high risk of automation in the Netherlands, which is 11%. Moreover, Haiss et al. (2020) working with the data from micro-census labor force survey carried out by Statistics Austria (2015), calculated that more than 40% of the Austrian employment is threatened by a high risk of computerization. Their results suggest that three general groups, more precisely clerical support workers, service and sales workers as well as craft and related trade workers, consists of more than 72% of people working in high-risk occupations. However, according to them, only a small proportion of occupations from a high-risk category will be completely automated in the near future. The vast majority of these occupations will rather go through major changes in the requirements in terms of competences, skills and education of workers and also tasks performed within these occupations.

Furthermore, Acemoglu and Restrepo (2019) suspect that automation will have multiple effects. The first will manifest itself in terms of the job's destruction and can

be named as the so-called displacement effect. It will mainly represent the cost of automation. The advantages connected to automation are characterized as a productivity effect that makes industry capable of producing more and cheaper goods leading to more profitable companies and allowing them to hire more employees. Moreover, humans can benefit from the new jobs like a robot technician or a software coder. These benefits of new technologies are often called as the reinstatement effect. The authors (Acemoglu and Restrepo, 2019) were trying to find out which of these effects is more likely to dominate. The productivity and reinstatement effects of new technologies were so large between 1947 and 1987 that they were able to more than make up for the so-called displacement effects. One can explain the recent stagnation of labor demand by an acceleration of automation, mostly in manufacturing, and a deceleration in terms of creating new tasks. Besides that, many economies also experienced a slowdown in productivity growth, leading to a slowdown in demand.

Most recently, one of the first results on how employment has changed in high risk occupations suggests no massive job losses (Georgieff and Milanez, 2021). In their paper, they used a task-based measure of automation risk to study whether countries and jobs that were identified as having a high risk of automation in 2012 experienced declines in employment by 2019. They claim that between 2012 and 2019, all 21 examined countries experienced employment growth, but it has been considerably lower in high risk jobs (6%) in comparison with jobs in a low risk category (18%). Moreover, it is striking that this growth in employment has been very similar across all educational groups, which implies that the employment rate of the low-educated workers has not grown less than of the more educated.

3 Methodology and Data

The aim of the paper is to apply the estimates of automation probabilities used by Frey and Osborne (2017) and substitution potentials by Mihaylov and Tjidsens (2019) to detailed Slovak employment data from Trexima. We use the data at the national level for 401 4-digit SK ISCO-08 occupations for years 2014 and 2019.

One can find the estimates of the probabilities of automation for 702 occupations in the Appendix of the aforementioned paper by Frey and Osborne (2017). The estimates of the substitutional potential for more than 300 4-digit ISCO-08 occupations were not directly in the paper by Dengler and Matthes (2018), we had to request them from the authors. These estimates are easily applicable to our data, as they use the same occupation classification. When working with the automation probabilities by Frey and Osborne (2017), we had to use a crosswalk between ISCO-08 and the 2010 SOC. The crosswalk is available at the Bureau of Labor Statistics website. Frey and Osborne (2017) distinguish between various types of occupations, more precisely high-, medium- and low-risk, depending on their automation probabilities. This categorization is also used by Dengler and Matthes. Therefore, this categorization is used in this paper, too.

The possibility of comparing the extent to which automation threatens the labor market of a particular country with other countries is the main advantage of working

with the estimates of Frey and Osborne (2017). This is also the reason why the similar methodology has been applied by several other authors. The disadvantage lies in the process of translating their estimates of the automation probability from the American to the international classification of occupations. This country-specificity issue is to some extent present also in the case of the estimates of Dengler and Matthes (2018) since their estimates are based on the tasks performed within individual occupations in Germany. Their paper assesses the possibilities of replacing approximately 8,000 tasks with computers or computer-controlled machines. Each of these tasks was independently examined by three coders to find out if they could be performed fully automatically by a computer-controlled machine or a computer algorithm in 2013. In this paper, we calculate employment growth in different occupations in Slovakia between 2014 and 2019. For the estimation of the relationship between automation probabilities (substitution potentials) and the employment growth during that period, we use an unweighted OLS regression.

4 Empirical Results

Similar to Dengler and Matthes (2018) or Georgieff and Milanez (2021), we analyze the relationship between automation risk and occupational employment growth between 2014 and 2019. The results for Slovakia are very similar as the one for Germany, suggesting that employment growth declines significantly with the increasing risk of automation.

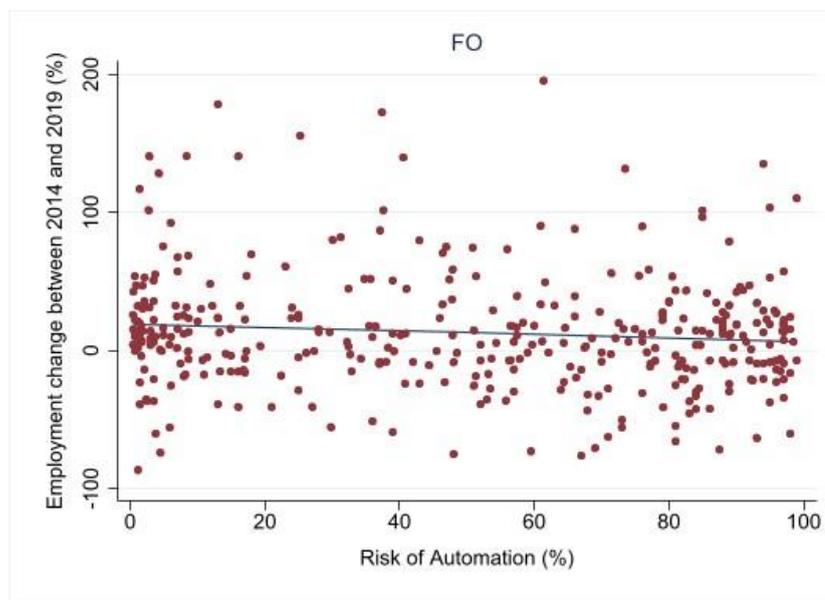


Fig. 11. Employment growth by risk of automation, Slovakia, based on estimates by Frey and Osborne (2017)

As can be seen in Figure 1 and Figure 2, this is true when using both estimates by Frey and Osborne (2017) and Dengler and Matthes (2018). Over the five-year period, Slovakia experienced employment growth of about 11%, however, it was much lower in occupations at a high risk of automation, namely 9% for the most automatable occupations according to Frey and Osborne and only 4% applying the estimates of Dengler and Matthes.

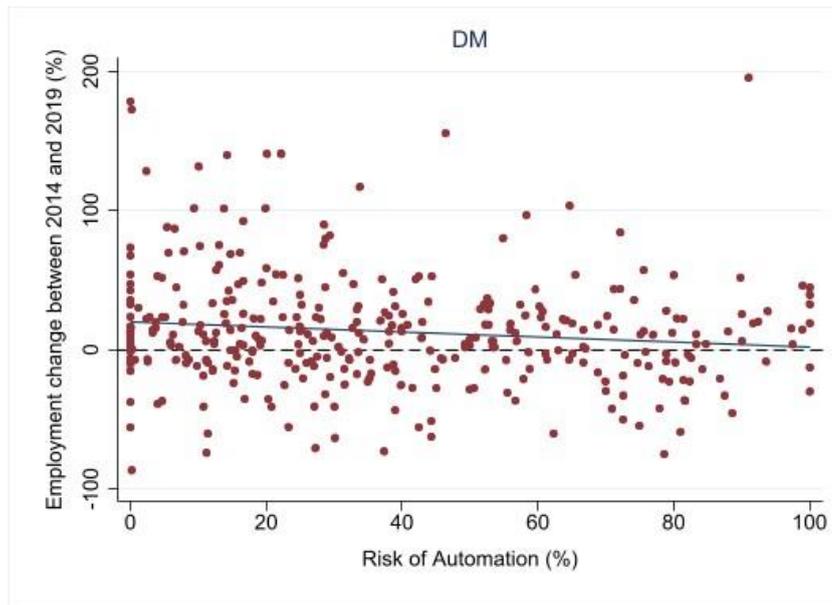


Fig. 2. Employment growth by risk of automation, Slovakia, based on estimates by Dengler and Matthes (2018)

Looking at Table 1, we find that the employment growth declines by approximately 1.3 percentage points if the risk of automation increases by 10 percentage points when applying the Frey and Osborne estimates (column 1), while in the case of Dengler and Matthes substitution potentials, the employment growth declines by approximately 1.9 percentage points if the risk of automation increases by 10 percentage points (column 2). The results are significant at the 5% significance level.

Table 9. Employment growth and a risk of automation in Slovakia (2014–2019)

VARIABLES	(1) Employment change	(2) Employment change
Automation risk_FO	-0.133** (0.0648)	
Automation risk_DM		-0.186** (0.0752)
Constant	19.14*** (3.925)	20.24*** (3.529)
Observations	369	358

R-squared

0.011

0.017

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Furthermore, it is also in compliance with the recent findings of Georgieff and Milanez (2021) that all 21 examined OECD countries experienced employment growth over the past decade with much lower increase in jobs at high risk of automation – 6% versus 18% in jobs at lower risk. However, as they explain, lower employment growth in high-risk occupations has not been accompanied by a shift of the low-educated away from high-risk and into lower-risk occupations. This can be rather explained by the fall in job opportunities for these workers, leading to a decline in their absolute number and accompanied by a general upskilling of the workforce. Also, the remaining low-educated workers have become even more concentrated in high-risk occupations, which represents major policy challenges. They also add that countries with higher automation risk back in 2012 experienced higher employment growth until 2019, which is consistent with a theory that automation contributes to positive employment growth through its productivity effect.

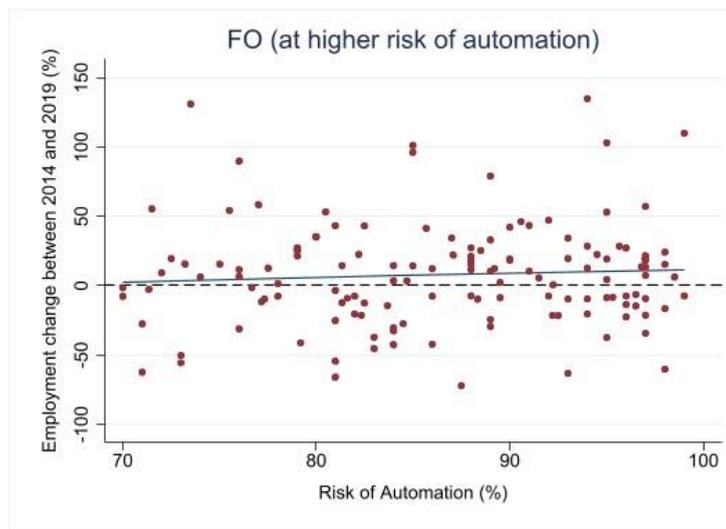


Fig. 3. Employment growth in occupations with high risk of automation, Slovakia, based on estimates by Frey and Osborne (2017)

Looking at Figure 3 and Figure 4, we can specifically examine the employment growth in jobs with the highest risk of automation. As previously mentioned, we see a growth even in the potentially highly automatable jobs, but it is lower than the overall employment growth during the period. Therefore, there is no indication that the higher risk of automation is associated with employment decline. This is true applying both automation probabilities estimates to the Slovak economy.

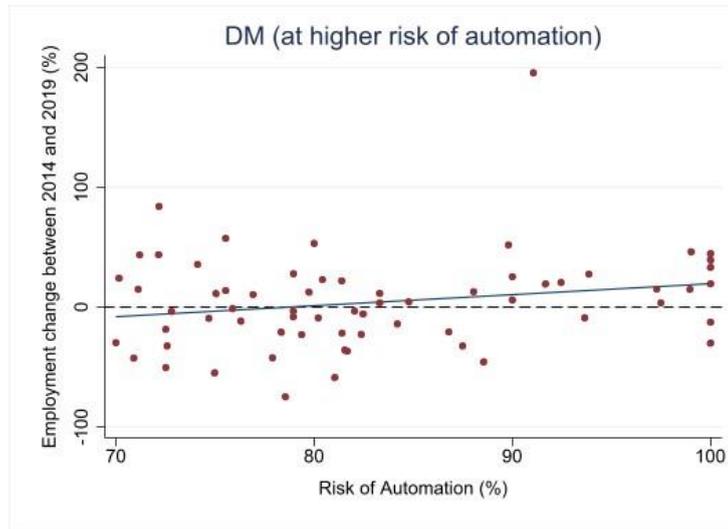


Fig. 4. Employment growth in occupations with high risk of automation, Slovakia, based on estimates by Dengler and Matthes (2018)

Occupations with the highest risk of automation according to Frey and Osborne (2017) that saw significant increase in employment (Table 2) include specific kind of drivers, insulation workers, salespersons, jewelry and precious-metal workers, kitchen helpers, medical secretaries or woodworking-machine tool setters and operators. On the other hand, the highest risk occupations with most prominent decline in the last five years are fast food preparers, hand launderers and pressers, blacksmiths, hammersmiths and forging press workers, legal secretaries, printers etc.

Table 2. Highest increase and decrease in employment for the occupations with the risk of automation above 70 %, Slovakia, based on estimates by Frey and Osborne (2017)

ISCO Code	Name	Employment change (%)	Risk of Automation (FO)
Highest increase in employment (%)			
9331	Hand and pedal vehicle drivers	135,0	94,0
7124	Insulation workers	131,2	73,5
5244	Contact center salespersons	110,0	99,0
7313	Jewelry and precious-metal workers	103,2	95,0
9412	Kitchen helpers	101,4	85,0
3344	Medical secretaries	96,4	85,0
6122	Poultry producers	89,6	76,0
7215	Riggers and cable splicers	79,1	89,0
5132	Bartenders	58,6	77,0
7523	Woodworking-machine tool setters and operators	57,1	97,0
Highest decrease in employment (%)			

9411	Fast food preparers	-72,0	87,5
9121	Hand launderers and pressers	-65,7	81,0
7221	Blacksmiths, hammersmiths and forging press workers	-63,2	93,0
3254	Dispensing opticians	-62,6	71,0
3342	Legal secretaries	-60,3	98,0
7125	Glaziers	-55,7	73,0
4131	Typists and word processing operators	-54,6	81,0
8152	Weaving and knitting machine operators	-50,3	73,0
7322	Printers	-45,5	83,0
7531	Tailors, dressmakers, furriers and hatters	-42,7	84,0

Source: Author based on data from Trexima Bratislava and Frey and Osborne (2017).

Based on the substitution potentials by Dengler and Matthes, the riskiest occupations which experienced highest increase in employment in Slovakia include power production plant operators, woodworking-machine tool setters and operators mechanical machinery assemblers, aircraft engine mechanics and repairers, plastic products machine operators and other, while the highest decline was present in occupations like shottfirers and blasters, upholsterers and related workers, typists and word processing operators, weaving and knitting machine operators, printers, tailors etc. (Table 3).

Table 3. Highest increase and decrease in employment for the occupations with the risk of automation above 70 %, Slovakia, based on estimates by Dengler and Matthes (2018)

ISCO Code	Name	Employment change (%)	Risk of Automation (DM)
Highest increase in employment (%)			
3131	Power production plant operators	195,5	91,1
2529	Database and network professionals not elsewhere classified	84,1	72,2
7523	Woodworking-machine tool setters and operators	57,1	75,6
8211	Mechanical machinery assemblers	53,3	80,0
7232	Aircraft engine mechanics and repairers	51,9	89,8
8142	Plastic products machine operators	46,2	99,0
7535	Pelt dressers, tanners and fellmongers	44,3	100,0
3252	Medical records and health information technicians	43,6	72,1
8143	Paper products machine operators	43,3	71,2
7521	Wood treaters	39,40	100,00
Highest decrease in employment (%)			
7542	Shottfirers and blasters	-75,0	78,6
7534	Upholsterers and related workers	-59,0	81,0
4131	Typists and word processing operators	-54,6	75,0

8152	Weaving and knitting machine operators	-50,3	72,5
7322	Printers	-45,5	88,6
7531	Tailors, dressmakers, furriers and hatters	-42,7	70,9
7113	Stonemasons, stone cutters, splitters and carvers	-42,2	77,9
7317	Handicraft workers in wood, basketry and related materials	-36,9	81,7
7311	Precision-instrument makers and repairers	-36,1	81,6
3522	Telecommunications engineering technicians	-32,7	87,5

Source: Author based on data from Trexima Bratislava and Dengler and Matthes (2018).

5 Conclusion

To conclude, we found that occupations at a higher risk of automation experienced lower employment growth between 2014 and 2019 in Slovakia. While the overall employment growth was 11%, it was 9% for the most automatable occupations identified by Frey and Osborne (2017) and only 4% applying the estimates of Dengler and Matthes (2018). Even though these results are confirmed by regression analysis, we do not provide any causal interpretation, since the risk of automation (substitution potential) is not the only explanatory factor for the employment growth in Slovakia.

Furthermore, high-risk occupations applying the Frey and Osborne estimates with the most prominent decline in the five-year period were fast food preparers, hand launderers and pressers, blacksmiths, hammersmiths and forging press workers, legal secretaries, printers, etc. Using the substitution potentials by Dengler and Matthes, the highest decline was present in occupations like shofirers and blasters, upholsterers and related workers, typists and word processing operators, weaving and knitting machine operators, printers, tailors and other. Future work could focus on the causal interpretation of the examined relationship and the corresponding policy recommendations.

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Industry 4.0 – Analysis of the Industry Sectors in Czech Republic and Slovakia

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Abstract. Industry 4.0 has become very popular topic in recent years for a lot of people, especially economists, technicians but also teachers. All of them are trying to find out how to implement the ideas of Industry 4.0 in their field, how to develop them and what impact the Industry 4.0 would have. A lot of them are worried about radical changes connected with the implementation is ideas of Industry 4.0, as they understand the Industry 4.0 initiative as revolutionary rather than evolutionary change. In the article, there are data from Eurostat for the NACE sectors breakdown from Czech Republic and Slovakia presented as the background for the main idea of not radical change caused by Industry 4.0. The development of chosen economical indexes for the time-period of 1995 till 2018 are analyzed to illustrate the development of the position of human labor and using the machinery in different kinds of sector types. As the aim of the article is to show, that the fear of radical changes connected with the Industry 4.0 initiatives, are not based on hard data and are more emotionally motivated.

Keywords: Industry 4.0, Labor Productivity, Wages

JEL classification: *O11, E24*

1 Introduction

The topic of Industry 4.0 relates to the idea of dramatic changes in ways of production, especially connected with the use of new technologies and changes in the labor market. The changes in competencies of future workers, which will be expected workers should have to be able to participate in production as employees, also create the expectation of changes in the vocational education and training [1, 2, 3]. There is also public debate accelerated by social media, which creates the fear of lots of jobs vanishing.

These ideas are based on the conviction that changes connected with the Industry 4.0 are radical. But if we look in the history, there were changes in production caused by industrialization [4, 5] and they were also connected with the same kind of fears. The emotional point of view, the fear of losing the individual competitive position of each

of us as a worker due to implementation of new technologies and need of new competencies is understandable at individual level. But there should be some-kind of global perspective which could make us calm and provide us with the suitable understanding that all the changes of implementation of Industry 4.0 would have positive effect on our lives.

Although it is true, that there are changes effecting production and employees due to Industry 4.0, but these changes are not radical nor endangering the position of workers in many companies in variety of economic sectors. Based on economic data, there will be presented the opinion that the Industry 4.0 is evolutionary change with possible positive impact on workers rather than revolutionary change. The idea is to prepare for changes inevitably coming and bringing the more productive and effective future to companies, workers, and consumers.

2 Methodology

The main idea of the article is to point out the development of chosen economical indexes to show the development of industrialization process in the Czech Republic and Slovakia in the sectors according to NACE breakdown. The indexes were chosen in such way that they can illustrate the labor productivity [6, 7] and other connected economic indexes [8, 9].

For the analysis, the data from Eurostat database were used. The data were analyzed in the time-period from 1995 till 2018, which is the longest range available with complete datasets. In the fact that there were, and in the Czech Republic still is, different currencies, the Euro was chosen as the summarizing currency for the whole time-period. The selected data were (with abbreviation in brackets):

- (O) output,
- (CoE) compensation on employees,
- (CoFC) consumption of fixed capital,
- (GFCF) gross fixed capital formation,
- (HTE) hours worked by employees within total employment,
- (PTE) number of employees within total employment as volume of persons.

Those data were analyzed for the whole national economy and in each sector type according to NACE classification as follows (with abbreviation in brackets):

- (All) total – all NACE activities,
- agriculture, forestry, and fishing,
- (B-E) industry except construction,
- (F) construction,
- (G-I) wholesale and retail trade, transport, accommodation, and food service activities,
- (J) information and communication,
- (K) financial and insurance activities,
- (L) real estate activities,
- (M-N) professional, scientific, and technical activities; administrative and support service activities,

- (O-Q) public administration, defense, education, human health, and social work activities,
- (R-U) arts, entertainment and recreation, other service activities; activities of household and extra-territorial organizations and bodies.

From the ratios the most important for the influence of the Industry 4.0 are the following (computation of ratios from economic variables in brackets):

- (CoE/O) personal costs,
- (CoFC/O) fixed costs,
- (O/PTE) workers productivity,
- (CoE/PTE) workers wage,
- (HTE/PTE) annual hours worked per employee.

In the graph there are mutual comparison of the selected variables and ratios presented to illustrate the development of whole economy (all sectors) and for each sector for both countries, Czech Republic, and Slovakia.

3 Data and analysis

As first step of the analysis the economy of Slovakia and Czech Republic are analyzed and presented in figure 1 and 2. The relationship between capital equipment and the volume of workers is presented, where capital equipment is represented by gross fixed capital formation and volume of workers is represented by thousands of persons employed recalculated for total full-time employment. This should capture the impact of Industry 4.0 and with the increase in technological investments there should be decrease in number of workers due to the replacement of manual work by machines. But there are no such trends in Czech economy nor Slovak economy.

Subsequently, similar view is also provided by the analysis of relationship between fixed costs and personal costs calculated as a share of output of Czech and Slovak economy. As in the previous case, there is a proportional increase in both ratios, indicating the overall economic development of both countries rather than the impact of Industry 4.0.

The assumption of ongoing economic development in both countries is also supported by the third analyzed relationship, which captures the relationship between labor productivity and workers' wages. This relationship is significantly the strongest. In addition, there is a noticeable time sequence of mutual increase of both variables, which in previous cases shows considerable fluctuation.

The last analyzed relationship reflects the impact to the hours worked per employee. There is negative relationship between the labor productivity and hours worked per employee. Here, a clear logic is shown, connecting the growing volume of capital equipment and at the same time the increasing productivity of labor, which is reflected in the improvement of working conditions of employees. The mentioned trend is also reflected in the wider discussions on the general reduction of working hours and is related to the development of society that prefers leisure time, which can be used for personal and personality development. It is thus possible to obtain more motivated and more satisfied employees.

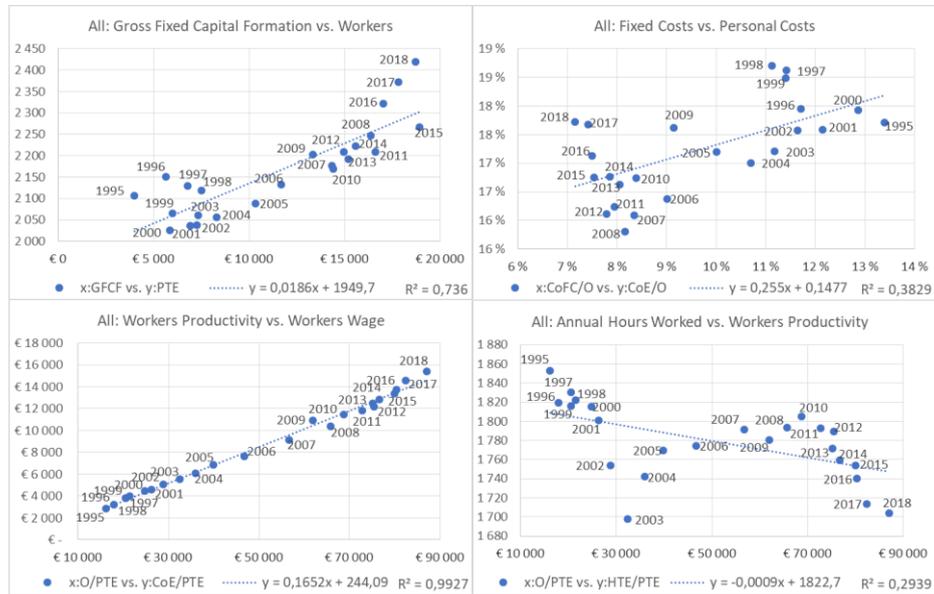


Fig. 12. Analysis of the selected indicators for all sectors in Slovakia.

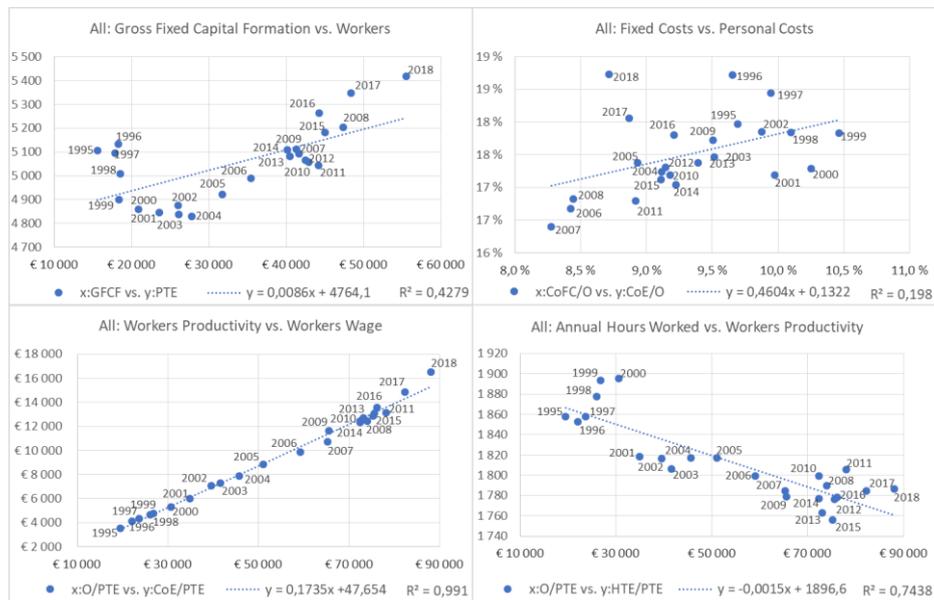


Fig. 2. Analysis of the selected indicators for all sectors in the Czech Republic.

Although the analysis of selected relationships in relation to Industry 4.0 for the whole economy of both countries does not indicate significant changes and rather points to positive effects on workers, the situation may differ in individual sectors. The results

of the analysis of the abovementioned relationships between selected indicators for Slovakia are presented in table 1 and for the Czech Republic in table 2.

In all analyzed sectors in both countries, as in the previous analysis of whole economy, there was a very close direct relationship and statistically very significant relationship between labor productivity and workers' wages. Thus, there is no situation where the increase in labor productivity would not be accompanied by an increase in workers' wages, caused, for example, by their replacement by technologies or machinery in the production process.

Also, the analyzed relationship between the labor productivity and hours worked per employee shows an inversely proportional and statistically significant relationship almost in all sectors in both countries. There are exceptions especially in Slovakia, where there are sectors with directly proportional relationship or statistically not significant relationship. For example, in Slovak construction sector, where due to increase of hours worked till 2010, the relationship is directly proportional and statistically significant.

Table 1. Analysis of selected indicators for sector breakdown of Slovak economy
SLOVAKIA

	Annual Hours Worked			Labor Productivity			Annual Hours Worked vs. Productivity	
	min.	max.	average	min.	max.	average	y: HTE/PTE vs. x:O/PTE	R ²
A:	1,796	2,038	1,894	7,801	62,265	33,225	$y = -0.0008x + 1,920.5 (-)$	0.0920 (!)
B-E:	1,675	1,778	1,739	23,431	159,321	90,435	$y = 0.00002x + 1,736.7$	0.0023 (!)
F:	1,786	2,038	1,922	16,310	90,562	51,687	$y = 0.0015x + 1,845.3$	0.3765
G-I:	1,728	1,886	1,819	14,278	53,106	33,772	$y = -0.0015x + 1,870.1 (-)$	0.1823
J:	1,752	1,918	1,854	17,428	105,154	69,489	$y = -0.00007x + 1,858 (-)$	0.0029 (!)
K:	1,687	1,821	1,758	25,894	107,160	71,142	$y = -0.0004x + 1,786.5 (-)$	0.1307
L:	1,639	1,861	1,770	123,904	439,668	269,567	$y = -0.0004x + 1,882.0 (-)$	0.4502
M-N:	1,742	1,981	1,881	12,070	69,220	36,713	$y = -0.0025x + 1,970.5 (-)$	0.5625
O-Q:	1,558	1,831	1,660	7,337	35,419	20,490	$y = -0.0075x + 1,814.3 (-)$	0.7030
R-U:	1,654	1,908	1,785	10,137	64,886	36,924	$y = -0.0022x + 1,864.4 (-)$	0.2561
	Fixed Costs			Personal Costs			Fixed Costs vs. Personal Costs	
	min.	max.	average	min.	max.	average	y:CoE/O vs. x:CoFC/O	R ²
A:	9.3 %	18.2 %	11.2 %	13.8 %	27.9 %	20.4 %	$y = 1.5937x + 0.0249$	0.3439
B-E:	5.6 %	10.5 %	7.4 %	8.9 %	13.7 %	10.9 %	$y = 0.7043x + 0.0563$	0.4382
F:	1.2 %	12.1 %	2.5 %	10.1 %	18.6 %	12.9 %	$y = 0.7902x + 0.1097$	0.5918
G-I:	5.3 %	10.0 %	6.8 %	17.6 %	25.7 %	22.0 %	$y = -0.8694x + 0.2791 (-)$	0.1475
J:	11.4 %	41.7 %	20.5 %	17.0 %	23.0 %	19.4 %	$y = -0.0911x + 0.2123 (-)$	0.1535
K:	4.8 %	26.6 %	10.6 %	16.2 %	29.2 %	22.4 %	$y = 0.3859x + 0.1829$	0.4677
L:	24.3 %	42.8 %	32.7 %	2.5 %	3.9 %	3.2 %	$y = -0.0365x + 0.0435 (-)$	0.2425
M-N:	2.3 %	12.1 %	4.5 %	17.6 %	24.6 %	21.3 %	$y = 0.1144x + 0.2074$	0.0144 (!)
O-Q:	9.3 %	27.9 %	18.8 %	40.9 %	52.7 %	46.9 %	$y = -0.4998x + 0.5627 (-)$	0.7869
R-U:	3.1 %	15.5 %	5.7 %	14.3 %	27.8 %	19.0 %	$y = 0.5297x + 0.1603$	0.2228
	Gross Fixed Capital Formation			Number of Workers			Gross Fixed Capital Formation vs. Workers	
	min.	max.	average	min.	max.	average	y:PTE vs. x:GFCF	R ²
A:	107	800	431	71	202	104	$y = -0.1608x + 173.14 (-)$	0.6179
B-E:	1,435	6,983	4,347	512	642	568	$y = -0.0121x + 620.79 (-)$	0.3387
F:	25	448	221	120	187	155	$y = 0.1289x + 129.62$	0.6273
G-I:	583	3,774	1,937	409	633	541	$y = 0.0634x + 417.77$	0.7625
J:	272	1,562	715	40	71	50	$y = 0.0104x + 42.631$	0.0900 (!)
K:	117	440	241	29	47	39	$y = 0.0113x + 36.187$	0.0382 (!)
L:	99	3,794	1,677	17	29	21	$y = 0.0032x + 15.432$	0.7919
M-N:	105	1,315	484	109	253	173	$y = 0.0866x + 130.91$	0.5573
O-Q:	394	3,052	1,498	441	479	456	$y = 0.0010x + 454.10$	0.0073 (!)
R-U:	49	334	144	51	76	61	$y = 0.0600x + 52.805$	0.5860

Note: (-) means that the relationship is inversely proportionate; (!) means that relationship is weak

Table 2. Analysis of selected indicators for sector breakdown of Czech economy

CZECH REPUBLIC								
	Annual Hours Worked			Labor Productivity			Annual Hours Worked vs. Productivity	
	min.	max.	average	min.	max.	average	y: HTE/PTE vs. x:O/PTE	R ²
A:	1,913	2,044	1,969	15,361	63,839	38,536	$y = -0.0006x + 1,993.6$ (-)	0.1283
B-E:	1,694	1,832	1,752	26,299	131,040	80,883	$y = -0.0008x + 1,813.6$ (-)	0.5840
F:	1,887	2,061	1,966	19,241	83,927	53,647	$y = -0.0022x + 2,081.7$ (-)	0.7071
G-I:	1,809	1,984	1,886	14,505	62,592	37,976	$y = -0.0031x + 2,003.5$ (-)	0.7998
J:	1,743	1,921	1,835	32,792	122,749	86,101	$y = -0.0014x + 1,958.8$ (-)	0.7239
K:	1,662	1,827	1,743	38,595	145,321	95,144	$y = -0.0009x + 1,832.9$ (-)	0.5686
L:	1,810	2,063	1,961	83,555	312,555	188,978	$y = -0.0007x + 2,090.7$ (-)	0.4699
M-N:	1,678	1,886	1,788	17,754	70,740	45,332	$y = -0.0031x + 1,930.5$ (-)	0.8201
O-Q:	1,667	1,770	1,709	10,317	42,216	26,696	$y = -0.0011x + 1,737.7$ (-)	0.1434
R-U:	1,693	1,895	1,810	15,746	63,839	32,366	$y = -0.0032x + 1,912.5$ (-)	0.3783
	Fixed Costs			Personal Costs			Fixed Costs vs. Personal Costs	
	min.	max.	average	min.	max.	average	y:CoE/O vs. x:CoFC/O	R ²
A:	8.3 %	10.6 %	9.2 %	14.9 %	21.6 %	18.5 %	$y = 0.4730x + 0.1415$	0.0209 (!)
B-E:	5.9 %	8.1 %	6.8 %	11.9 %	15.0 %	13.1 %	$y = 1.1521x + 0.0520$	0.6516
F:	2.5 %	4.2 %	3.2 %	11.0 %	17.7 %	13.2 %	$y = -1.6585x + 0.1853$ (-)	0.2553
G-I:	8.4 %	10.1 %	9.2 %	19.3 %	22.3 %	21.0 %	$y = -0.1225x + 0.2217$ (-)	0.0075 (!)
J:	11.9 %	18.1 %	14.8 %	15.6 %	23.3 %	18.9 %	$y = 0.7391x + 0.0800$	0.2449
K:	8.4 %	12.2 %	9.7 %	16.9 %	23.2 %	19.9 %	$y = 1.2653x + 0.0763$	0.6930
L:	18.0 %	27.7 %	21.8 %	2.6 %	3.3 %	3.0 %	$y = -0.0114x + 0.0320$ (-)	0.0296 (!)
M-N:	6.2 %	10.0 %	8.3 %	16.4 %	19.9 %	18.0 %	$y = -0.0284x + 0.1826$ (-)	0.0006 (!)
O-Q:	15.6 %	21.5 %	18.8 %	39.9 %	51.0 %	44.0 %	$y = -1.5052x + 0.7220$ (-)	0.7941
R-U:	6.7 %	9.1 %	7.9 %	15.1 %	24.4 %	19.1 %	$y = 2.5193x - 0.0070$	0.5508
	Gross Fixed Capital Formation			Number of Workers			Gross Fixed Capital Formation vs. Workers	
	min.	max.	average	min.	max.	average	y:PTE vs. x:GFCF	R ²
A:	404	1,653	941	159	269	192	$y = -0.0641x + 252.59$ (-)	0.4656
B-E:	6,308	15,864	10,566	1,379	1,617	1,496	$y = -0.0043x + 1541.4$ (-)	0.0453 (!)
F:	486	1,704	1,062	402	523	439	$y = -0.0361x + 476.93$ (-)	0.2553
G-I:	2,331	9,185	5,692	1,130	1,285	1,199	$y = 0.0182x + 1094.8$	0.4988
J:	553	3,971	1,965	80	154	114	$y = 0.0269x + 61.335$	0.7869
K:	428	2,274	973	71	97	88	$y = 0.0074x + 80.710$	0.2478
L:	1,585	11,625	6,548	55	103	83	$y = 0.0050x + 50.461$	0.9110
M-N:	766	3,378	1,812	320	479	392	$y = 0.0550x + 292.06$	0.9309
O-Q:	1,115	6,592	3,770	861	978	895	$y = 0.0104x + 855.37$	0.3328
R-U:	180	827	574	126	194	160	$y = 0.0844x + 111.17$	0.6500

Note: (-) means that the relationship is inversely proportionate; (!) means that relationship is weak

In Slovakia, three stages of development of the relationship between labor productivity and hours worked can be identified in all sectors: In 90s, there was decrease in hours worked, then by 2010 stagnation or slight growth accompanied by an increase in labor productivity occurs, and subsequent often sharp decline in hours worked, even without a proper change in labor productivity, comes. In the Czech Republic, only the significant increase of labor productivity in period of 2000-2010 can be identified.

In most sectors, a directly proportional and statistically significant relationship between gross fixed capital formation and number of workers can be identified. However, in the case of both countries, an inversely proportionate and statistically significant relationship between these variables in the agriculture sector can be identified. There is a significant decrease in the number of workers in the 90s and subsequent stabilization in the following period. It seems, the change has its connection with the transition process in both economies, and the decline of importance of agriculture sector within the economies of both countries. The negative connection is

also evident in the industry sector, even though the period of more significant inversely proportionate relationship in the 90s is replaced, especially in the Czech Republic, by a transition to directly proportional relationship. In the Czech Republic there is inversely proportional relationship also in construction sector.

Last analyzed and interesting area identified is the relationship between fix costs and personal costs. The direct proportional relationship in sectors indicate the mutual development of the importance of labor and technology, and the need to finance them due to rising costs. In other sectors with inversely proportional relationship, it can be characterized as statistically insignificant or only weakly statistically significant. The exception is the sector of public administration, health, and education. There is decrease in fixed costs and increase in personal costs, and the personal costs are the highest among all sectors for all time. The sector is specific due to dominant position of the state, and its influence both in the field of investment in technology and on personal costs, due to the regular increasing in salaries of civil servants.

4 Conclusion

The aim of the article was to identify changes in relatively long time-period – 24 years from 1995 to 2018. According to the analysis and results it seems that the analyzed countries are developing in their production possibilities – increase of output. Also, the increase of production possibilities is enabling the enterprises to use more financial sources for the investments. Increase of the consumption of fixed capital, compensation on employees connected with wages, and in labor productivity can be identified. This process of increasing the various economic indexes is also connected with the decrease of time spent in the work. Although same distinctive changes among selected indexes can be identified, the whole development is rather fluent change than jump revolution.

According to comparison of the situation of analyzed indexes in the year 2018 in the Czech Republic and Slovakia it seems that both countries has quite similar economical settings nowadays in analyzed areas. But there are differences in the development of the analyzed ratios during the time-period. This can be due to different starting positions back in 90ties [10], as both countries separate from each other in 1993, and before then there were mutual currency, government, enterprises, and other socio-cultural connections.

This analysis builds on previous analyzes [11, 12], and confirms that even if technological changes occur, the volume of fixed assets increases or fixed costs increase, there is no replacement of human labor by machines, and as a result positive effect on employees can be identified. The logical link between the analyzed variables can be identify, when there is a technological development and investment to the new technologies, which creates space for job creation even within increasing pressure of competition, not only on the domestic market but also on the international market. The increase in investment in technology also creates space for growth in labor productivity and enables continuous increase in wages and salaries. This creates positive effects in relation to employees, specifically in higher employment and reduce hours worked per employee.

Results of the analysis thus corresponds to other studies that identify significant contribution of technological development, informatization, and digitization, as source or expression of Industry 4.0, in the field of labor productivity [13, 14]. The development of both analyzed economies and further technological investments creates opportunity to maintain prosperity and high level of production and consumption, despite ageing population and in more ecologic economy [15]. The growth of GDP and labor productivity as the benefits of Industry 4.0, and identification of the area of industrial production as an area with huge potential for development has been identified for Slovak economy [16].

Although Industry 4.0 does not lead to radical changes in the economy, but rather to a smooth transition to more efficient production methods and higher productivity, and employees do not have to worry about being substituted by technology, there remains another area where concerns about Industry 4.0 may arise, and that area is education in the form of preparation for future occupations. Especially in the field of vocational education, there are and will be changes in the educational content and forms of teaching in the future [3]. It will be necessary to develop new competencies of future employees, related to digitization and other technologically developed areas [17]. However, it will be necessary to develop competencies not only in connection with technology, but also in the field of creativity, emotional intelligence, critical thinking, and interpersonal relationships [18]. Both in the focus on employees and in the focus on managers and future entrepreneurs [19].

The analysis of individual industries points to different developments in individual industries and different degrees of current and potential impact of Industry 4.0 in the future. However, it confirms that these are not radical changes that threaten employees, but rather a gradual development with a positive potential impact on employees [20].

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Cluster analysis of the EU banking sector based on EBA Risk Indicators

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Abstract. Banking sector plays a key role in financial system of every developed country. To know possible weaknesses proper risk management is necessary. European Banking Authority (EBA) is the arterial institution in attempt to consolidate risk management among different countries of European Union. EBA discloses on quarterly basis various Key Risk Indicators (KRIs) for all EU member countries. The goal of this paper is to analyze chosen KRIs of all EU countries and based on distances and similarities among them, insert them into homogenous groups. The purpose of the analysis is to seek insights into different countries bank's sector and finding similarities among them, which might not be visible at the first glance. For the research, both hierarchical and non- hierarchical cluster analysis were performed. Results show that we could observe four groups of states which could be, with a little generalization, labeled as eastern countries, southern countries, northern countries and middle and core countries of EU, based on analyzed KRIs.

Keywords: cluster analysis, EU banking sector, risk indicators.

JEL classification: C 38, G 21.

1 Introduction

Banks are important institutions of financial sector, and their economic health is essential for stable growth of national economy. To know strengths and weaknesses of banks it necessary to monitor their risk exposure. For banks in European Union, one of the most important institutions that monitors various risk data from all member states is the European Banking Authority (EBA). EBA is specialized agency of the European Union set up to achieve a more integrated approach to banking supervision across the

EU [6]. One of the core tasks of EBA is to establish a single set of rules applicable to all banking institutions in the EU in the same manner. This is also precondition for an EU single market in the banking sector.

One of the main responsibilities of EBA is to monitor banking risk. In February 2011, EBA started collecting statistical information of 55 banks across 20 European Economic Area (EEA) countries [5]. From these data EBA constructed Key Risk Indicators (KRIs). These KRIs are ratios, which are expected to provide early warning signs of trends, potential risks and vulnerabilities in the EU banking sector. Information regarding KRIs started to be published by EBA quarterly as EBA Risk Dashboards [7] in order to provide general information regarding risk factors of banking sector of EEA countries.

The aim of this paper is to find similarities among countries of the European Union based on EBA KRIs by usage of the cluster analysis. Analysis is performed on EBA Risk Dashboard data set as of December 2020 on chosen KRIs. Based on the results of the analysis, the goal is to compare bank system among EU countries and find insights on similarities and differences through countries.

2 Definition of chosen KRIs

From available indicators in EBA Risk Dashboard we have decided to choose five, which are expected to cover different areas of banking sector's risk appetite and financial profitability on country basis. These indicators, as defined by EBA [7], are:

1. Capital Adequacy Ratio (CAR),
2. Leverage Ratio (LR),
3. Return on Equity (RoE),
4. Loans-to-deposit ratio for households and non-financial corporations (LtD),
5. Liquidity Coverage Ratio (LCR).

Capital Adequacy Ratio is a measurement of bank's available capital which is expressed as a percentage of bank's risk weighted assets. Its purpose is to protect depositors and promote stability and efficiency of financial system. Capital used to calculate the capital adequacy ratio is according to BCBS standards [3] divided into two tiers. First tier consists of Common Equity Tier 1 and other Tier 1 capital and consists of equity capital, ordinary share capital, intangible assets and audited revenue reserves. Tier 2 capital consists of unaudited reserves and general loss reserves [13]. Risk weighted assets are bank's balance and off-balance sheet exposures weighted according to risk. Capital adequacy ratio is calculated as following:

$$CAR = \frac{\textit{Tier 1 capital} + \textit{Tier 2 capital}}{\textit{Risk Weighted Assets}} \quad (1)$$

Leverage ratio is defined as the capital measure divided by the exposure measure and is expressed as a percentage:

$$LR = \frac{\text{capital measure}}{\text{exposure measure}} \quad (2)$$

The capital measure is total Tier 1 capital. The exposure measure is the sum of balance sheet exposures, derivatives exposures, securities financing transaction exposures and off-balance sheet items [9]. According to BCBS [1] LR is intended to restrict the build-up leverage in the banking sector to avoid destabilizing deleveraging processes that can damage the broader financial system and the economy and is supposed to reinforce the risk-based capital requirements with a simple, non-risk-based “backstop” measure. Leverage ratio must exceed 3% and high percentage means that bank have sufficient amount of capital to cover its risk exposure.

Return on equity is a financial measure of how effectively a bank generates profit from the money that investors have put into the business. ROE is calculated by dividing net income by total shareholders’ equity:

$$ROE = \frac{\text{net income}}{\text{average shareholder's equity}} \quad (3)$$

In banking sector ROE was found out to be a better metric at assessing the market value and growth than earning per share growth widely used in other sectors. Investors are interested in having ROE as high as possible.

Loans-to-deposit ratio for households and non-financial corporations (LtD) helps assess bank’s liquidity position. According to EBA methodology [5] LtD is calculated as total loans and advances divided by total liabilities and gives an indication for which share of loans is funded by depositors:

$$LtD = \frac{\text{total loans and advances}}{\text{total deposits}} \quad (4)$$

LtD is expressed as percentage and value highly above 100% indicates that bank uses extensively other sources of funding than deposits.

Liquidity coverage ratio is designed to ensure that a bank maintains an adequate level of unencumbered, high-quality assets that can be converted into cash to meet its liquidity needs for a 30-day time horizon under an acute liquidity stress scenario specified by supervisors [4]. LCR is defined as followed:

$$LCR = \frac{\text{stock of High Quality Liquid Assets (HQLA)}}{\text{total net cash outflow over next 30 calendar days}} \quad (5)$$

Asset to be eligible as an HQLA must be liquid during the stress period and easily convertible into cash without significant loss of the value. General guideline for an asset to be considered as an HQLA is to be eligible as collateral for the central bank’s liquidity facilities [8]. Total net cash outflows as defined according to BCBS [2] is total expected cash outflows minus total expected cash inflows in the specified stress scenario for the subsequent 30 calendar days. LCR must be maintained above 100% by

regulatory limit (for banks operating in EU legislative since 1.1.2018, even though former plan of BCBS was to fully implement LCR at amount of above 100% since year 2019).

3 Methodology and data description

Cluster analysis is a multivariate statistic method which purpose is grouping a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups. These groups are called clusters and cluster analysis is an important tool with respect to multivariate exploratory data analysis. According to [10] cluster analysis differs from other methods of classification such as discriminant analysis where classification pertains to known number of groups and the operational objective is to assign new observations to one of these groups.

In Cluster analysis grouping is done based on similarities or distances. Dissimilarity measures can be divided into four groups [12]:

- measures of distance,
- coefficient of association,
- correlation coefficient,
- probability measures of similarities.

Most of statistical packages (including programming language R used in this article) supports measures of distances (dissimilarities). Given two objects X and Y in a p dimensional space, a dissimilarity measure follows these conditions:

1. $d(X,Y) \geq 0$ for all objects X and Y,
2. if $d(X,Y) = 0$, then $X = Y$,
3. $d(X,Y) = d(Y,X)$.

Most commonly used metrics to compute distances are [10]:

- **Euclidean distance** – geometric distance in the multidimensional space:

$$d_{ij} = \sqrt{\sum_{k=1}^K (x_{ik} - x_{jk})^2} \quad (6)$$

- **Manhattan distance** – average difference across dimensions:

$$d_{ij} = \sum_{k=1}^K |x_{ik} - x_{jk}| \quad (7)$$

- **Mahalanobis distance** – eliminates influence of difference in variability of variables and influence of correlated variables:

$$d_{ij} = (x_i - x_j)^T * S^{-1} * (x_i - x_j) \quad (8)$$

Where S^{-1} stands for unified sample covariance matrix.

Methods of clustering are divided into two categories: Hierarchical and Non-Hierarchical. **Hierarchical cluster analysis** proceeds either by a series of mergers or successive divisions. Agglomerative hierarchical method starts with individual objects and most similar objects are grouped and these initial group are merged according to their similarities. Divisive hierarchical method works opposite direction, when a single initial object is divided into subgroups such that the object in one subgroup is further from the object in the other subgroup [11].

Objects can be clustered together based on linkage methods. Final results of the cluster analysis are very dependent from chosen method. Among most used linkage methods are following [12]:

- **Single linkage** (nearest-neighbor) – historical method. Each step combines two clusters that contain the closest pair of elements not yet belonging to the same cluster as each other.
- **Complete linkage** (furthest-neighbor) – each step combines two clusters based on distance between two elements that are furthest away from each other. Clusters with the shortest of these distances are merged together.
- **Average linkage** – distance between each pair of observations in each cluster is added up and divided by the number of pairs to get an average inter-cluster distance.
- **Centroid distance** – clusters with lowest distance between their centroids are merged together.
- **Ward's method** – different and the most used method which tend to produce homogenous clusters of relative same size and shape and tends to avoid small clusters. Ward's criterion minimizes the total within-cluster variance. To implement this method, it is necessary to find at each step pair of clusters that leads to minimum increase in total within-cluster variance after merging.

3.1 Data description

Data used for the cluster analysis are taken from EBA Risk Dashboard Q4 2020 [7] regarding 27 countries of the EU and related to 5 chosen KRIs. This dataset was chosen because it provides us the latest available data in the time of the research and already captures possible impacts of the Covid-19 pandemic. All KRIs are disclosed as percentage. However, given fact that average values among KRIs varies significantly and some KRIs are not allowed to achieve values greater than 100 % by definition and for some it is possible (or it is directly expected of them, like LCR), dataset was standardized according to (9), where x is the original feature vector, \bar{x} is the mean of that feature vector, and σ is it's standard deviation, with purpose to avoid stronger impact of some KRIs over others.

$$x' = \frac{x - \bar{x}}{\sigma} \quad (9)$$

EBA dataset provide average KRIs of biggest banks by country. Information is provided quarterly usually with 4 months of delay.

4 Results

At first, KRIs after regularization were tested for presence of correlation. High level correlation among chosen KRIs might corrupt results of cluster analysis due to correlation among distances. Results are shown on Fig. 1. On significance level 0,01 no correlation is present among KRIs, but correlation among Leverage ratio and Loan-to-deposit ratio ($p = 0,0009$). Given fact, that only one correlation relationship is statistically significant, we decided to carry on analysis on underlying data. Performing of principal components analysis or factor analysis prior clustering with purpose to obtain linear independent variables would lead to bigger information losses (in terms of interpretability) than gains this approach would provide.

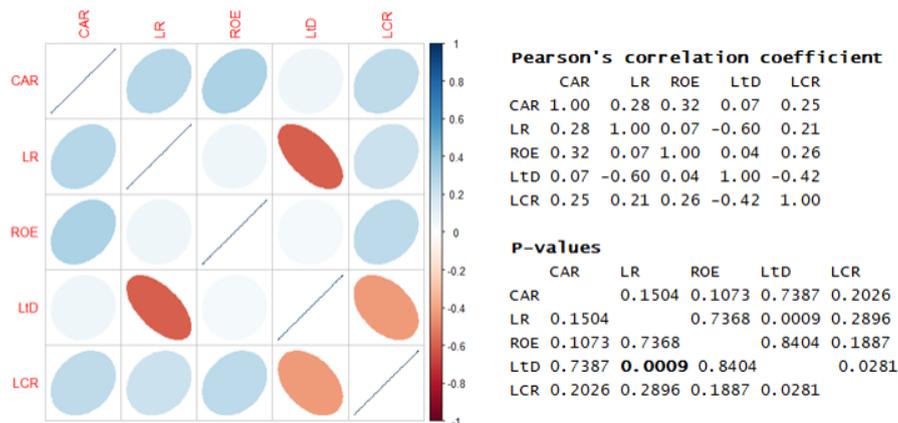


Fig. 13. Correlation coefficients of chosen KRIs and p-values of correlation tests in R.

Different linkage methods were used during the analysis with different number of clusters. Best results were achieved by usage of Ward's method and division into four clusters. These clusters were roughly the same size and were stable. Dendrogram showing division of countries into four clusters based on Euclidean distances by usage of Ward's method in hierarchical clustering is shown on Fig. 2. Division of countries based on clusters and their KRIs are shown on Fig. 3 and more insights provide summary table (Fig. 4) of average values of KRIs by clusters and their comparison to total average among all countries.

Results shows interesting cluster differences in Return on equity indicator. Average ROE among all EU countries is 0,43%. However, countries in second cluster (including Bulgaria, Estonia, Croatia, Lithuania, Latvia and Romania) have average ROE of 8 % which means, that banks in these countries achieved much higher profits in Covid-19 influenced year 2020 than banks in the rest of the EU. As a contrast, there is cluster 3 (consisting of Cyprus, Spain, Greece, Ireland, Malta, Portugal, and Poland) with

negative or null ROE at best. This cluster consists mainly of south EU countries which were hit by pandemic the worst and results shows that their banking system was severely hit as well. Countries in cluster 3 have also smallest average CAR ratio (19 %) which might indicate they might be lacking capital in case of ongoing crisis.

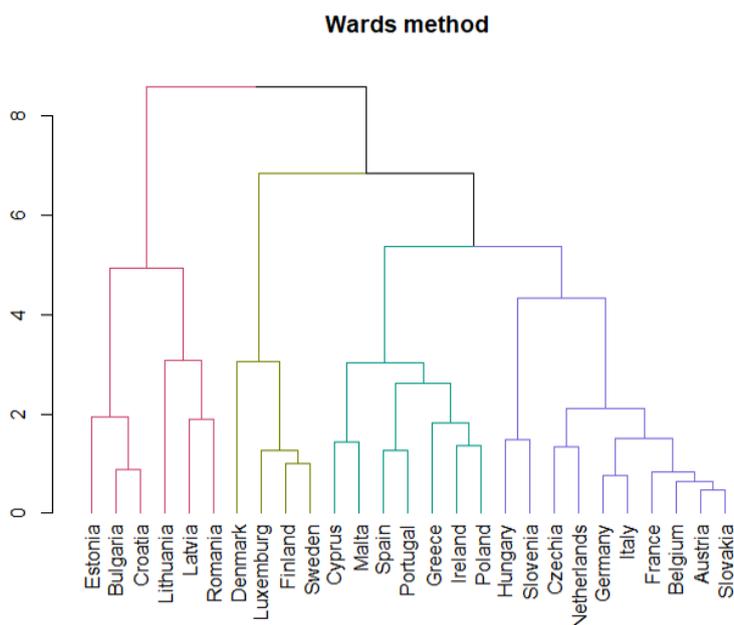


Fig. 2. Dendrogram of EU countries KRIs based on Ward's method of Hierarchical clustering (standardized distances on y-axis).

Moving back to cluster 2, another insight into these eastern European countries is that they have highest average of all KRIs, but Loan-to-deposit. Especially high is LCR indicator (average of 335% being 2.5x times higher than EU average) indicating high amount of liquid assets on bank's balances. We might expect that high ROE in hand with LCR might indicate that banks in these countries possess high amount of government bonds (probably with intention to help financing state debt due crisis) and bond spreads in these countries are significantly higher than, let us say, in Germany. This might help us explain, why these countries performed so well. Also given fact, that cluster 2 countries have highest CAR, meaning they have sufficient capital, we conclude banks in these countries are in good shape to absorb impact of the crisis. First cluster consist mainly of middle EU countries (like Czechia, Slovakia, Hungary and Austria) and the most important economics such as Germany, France, Italy, Belgium and Netherlands. Countries in cluster 1 are close to overall EU average in analyzed indicators. They are generally in good shape and their average values shows no extreme values (even though individual country KRIs on Fig. 3 might find some exceptions among particular countries). The last is cluster 4. This cluster we could label as northern countries because it consists of Denmark, Finland and Sweden. The last country in this smaller cluster is Luxembourg. All these countries belong among the best developed

countries in the world and their bank's balance sheet structure is, as the analysis shown, way different from the rest of EU countries. They have exceptionally high Loan-to-deposit ratio related to the rest of the countries. Average LtD in cluster 4 is 203 %, while total EU average as of December 2020 was 107 %.

Cluster	Country	CAR	LR	ROE	LtD	LCR
1	Austria	20%	7%	5%	97%	184%
1	Belgium	21%	7%	5%	97%	183%
1	Czechia	24%	7%	7%	77%	166%
1	Germany	20%	5%	0%	122%	158%
1	France	19%	6%	4%	106%	167%
1	Hungary	18%	9%	10%	75%	218%
1	Italy	20%	7%	0%	97%	187%
1	Netherlands	23%	5%	3%	113%	165%
1	Slovenia	17%	8%	17%	61%	294%
1	Slovakia	19%	7%	6%	105%	184%
2	Bulgaria	24%	12%	6%	67%	251%
2	Estonia	29%	10%	7%	99%	183%
2	Croatia	25%	13%	5%	68%	176%
2	Lithuania	24%	7%	11%	63%	763%
2	Latvia	29%	9%	7%	66%	420%
2	Romania	24%	10%	11%	57%	357%
3	Cyprus	20%	9%	-4%	56%	312%
3	Spain	17%	6%	-4%	105%	187%
3	Greece	17%	9%	-7%	78%	175%
3	Ireland	23%	10%	-3%	82%	172%
3	Malta	23%	7%	-3%	52%	383%
3	Poland	19%	10%	0%	84%	220%
3	Portugal	18%	7%	0%	79%	244%
4	Denmark	23%	5%	4%	294%	184%
4	Finland	21%	6%	6%	185%	172%
4	Luxembourg	24%	7%	6%	151%	152%
4	Sweden	23%	5%	9%	182%	169%

Fig. 3. Country's KRIs and cluster segmentation.

Average by cluster	CAR	LR	ROE	LtD	LCR
1	20%	7%	6%	95%	191%
2	26%	10%	8%	70%	335%
3	19%	8%	-3%	77%	242%
4	23%	6%	6%	203%	169%
Total average	21%	8%	0%	107%	221%
Cluster average to Total average					
1	95%	89%	1332%	89%	86%
2	121%	134%	1844%	65%	152%
3	92%	108%	-706%	71%	110%
4	109%	74%	1430%	189%	77%

Fig. 4. Average KRIs by clusters and comparison to total KRIs averages.

This means, that banks in these regions provided much more loans, than they possess deposits from customers (they have basically twice more loans than deposits). This shows us two things. First is, that households in these countries tend to be highly indebted and the second is diversion from standard source of funding in banking sector,

which are deposits. Banks have to gain deposits from customers in order to obtain funding, which they can use to lend loans. However, given long-time low interest rates caused by central banks with purpose to support economy leads to situation, when banks can issue covered bonds under extremely favorable conditions (for example in Denmark there were cases, when banks were able to issue covered bonds with negative interest, meaning they will pay less on maturity, than they borrowed). This all caused shift from standard sources of funding for banking industry, especially in these four countries. The rest of the KRIs of cluster 4 are quite comparable with total averages. They have slightly lowest LCR average, which might be caused by fact, that government bonds of these countries tend to yield very small interest (most likely negative) and therefore banks are not interested in possessing high amount of eligible assets in contrast to cluster 2 countries. For better visualization of clusters, choropleth map of EU is shown on Fig. 5.

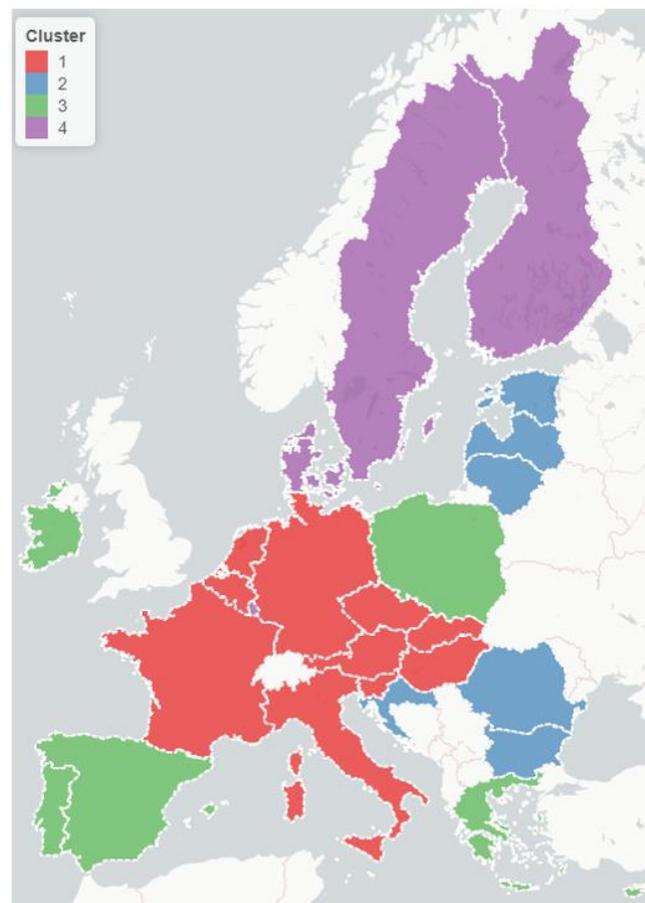


Fig. 5. Cluster segmentation based on hierarchical cluster analysis.

5 Discussion and conclusion

In this paper we focused on EU banking sector based on Risk Indicators which are on periodical basis disclosed by European Banking Authority with intent to compare different countries and find similarities and dissimilarities among them. For this purpose, cluster analysis was performed. Results from hierarchical cluster analysis are shown in this paper by usage of Ward's method and four clusters. During the analysis also non-hierarchical k-means algorithm with 4 centers was used in order to determine clusters and check feasibility of the hierarchical analysis. Results were the same as for hierarchical analysis and therefore only these are shown in the paper.

We divided countries into 4 clusters based on similarity among KRIs. First cluster consist mostly of middle and western European countries, which shows fairly average values of chosen KRIs. Second cluster we labeled as eastern EU countries, with surprisingly high return on equity and liquidity coverage ratio. Third cluster consists mostly of southern EU countries and is specific with very low profits (mostly losses) as shown by negative ROE and lowest available capital (CAR). This cluster is the most exposed to any upcoming crisis. Fourth and last cluster can be considered as north EU with specific of very high ratio of loans to deposits, depicting specifics of the country's banking sectors.

Analysis shows results as of December 2020. Some KRIs are quite significantly changing in time and for further research, comparison with 2021 results is suggested with purpose to identify changes during the year caused by development of coronavirus crisis and global economy. In the upcoming year, huge increase of banks balance sheet is expected, beside increased lending, also by increased drawing of TLTRO III (Targeted longer-term refinancing operations) from European Central Bank with purpose to borrow money under very favorable conditions. These operations (also significantly used by Slovak banks) will have huge impact on future development of several KRIs, such as Encumbrance ratio and Loan-to-Deposits ratio. Given their secured nature in terms of encumbered securities provided as a necessary collateral for central bank, also changes in LCR and LR are expected. Given fact, that balance sheet of banks in cluster 4 countries already bears high amount of encumbered collateral, we expect, that shift in other countries KRIs will be visible on year-to-year basis at the end of 2021 and movement in cluster average KRIs of first to third clusters will be closer to cluster 4 average KRIs.

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Importance of region and other socio-economic factors in the model of business efficiency

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Abstract. The importance of analyzing and predicting business efficiency, both overall and economic, is proving necessary, especially in the current global situation, when the world has been hit by a pandemic, causing economic slowdown, closures and, in some cases, fatalities and of course negative effects on the overall economy of countries and the world. In this paper, we focused on the analysis of indicators as predictors of business efficiency. We used a sample of 150,000 companies accounting in the double-entry bookkeeping system in Slovakia. Using data on enterprises, we calculated a number of financial indicators to which we added socio-demographic indicators and focused on the indicator of return on assets, in which we determined the strength of the region as a predictor of other indicators of corporate efficiency. As part of the analysis, we used Kruskal-Wallis statistical tests to determine differences and machine learning techniques such as the XGBoost Tree model and the CHAID algorithm to determine the significance of the predictor.

Keywords: Business, Efficiency, Machine Learning

JEL classification: C01, C38, C44, C53, M21

1 Business Efficiency

We understand the concept of efficiency in the economy as a state when the economy allocates its resources efficiently and thus uses them efficiently. Economic efficiency is a state where each resource is allocated in a way where resource waste is minimized. If the economy is economically efficient, any changes made to help one subject would harm another subject [1].

Business efficiency of enterprises is one of the main problems undertaken by economics studies [2]. Its always very important, it provides entrepreneurs with the possibility to survive, what is the key condition to realize other objectives such as

growth, development, maximizing owners benefits or building market value therefore it has a timeless character [2,3].

This issue is addressed by a number of authors, whose opinions differ in some cases but in many cases complement each other. In the literature one can find different definitions and interpretations for efficiency term, but generally it is considered from two perspectives: economic and organizational [4]. Lisý et al. (2007) speak of efficiency as the ability of the economy and its subjects to use resources as rationally as possible and to produce at the limit of production possibilities [5]. The output of the company is provided products and services, which arise from the consumption of production factors representing the inputs of the company. Thus, the ratio of output to input expresses the efficiency of the company [6,7].

The complexity of objective category for the organization and the variety of criteria to evaluate its efficiency the issue of its measurement and evaluation has multi-faceted character [2].

1.1 Measuring business efficiency

We can measure the efficiency of companies on the basis of several criteria. In its analysis, it is necessary to take into account both financial and socio - economic factors that affect it. The approach of different authors to evaluating the performance of organizations varies across studies, research, and articles, and the methods used to quantify them vary [8].

The most commonly used methods of measuring the economic efficiency of enterprises are considered to be:

- economic efficiency indicators,
- broader financial analysis, including the identification of economic standards.

In the analysis, we used several financial and non-financial socio-demographic indicators, focusing on the return on assets (ROA), because this indicators are considered indicators that characterize the efficiency of companies. The ROA indicator indicates how much profit an organization has made as a result of investing in its assets. The ROA indicator was calculated using the ratio:

$$\text{ROA} = \text{net profit} / \text{total assets};$$

it is the ratio between net income and total assets held by the entity [8]. The high level of this indicator highlights a high performance. The ROA indicator is often used to measure the efficiency and performance of companies, and is considered to be the most comprehensive indicator of measuring an organization's performance due to a combination of efficiency and effectiveness [9,10].

2 Data analysis

In the analysis, we focused on larger Slovak companies accounting in the system of double-entry bookkeeping, we worked with financial and non-financial indicators,

which include the region in which the company is located, its size, ownership. In the initial phase of data analysis, we calculated financial and economic indicators, while after adjusting the data, we were left with a final sample containing 149,236 companies containing data between 2016 and 2019 (because we only had data available in this time interval), on the basis of which we created the entire analysis. It was an analysis of companies in the time interval just before the outbreak of the Covid-19 pandemic.

In the first phase, based on the ROA indicator, we analyzed whether there are differences between individual regions of Slovakia, considering the distribution by region. The ROA indicator shows whether a company can use its resources efficiently. For more accurate results of the analysis, we cleaned the sample with companies whose ROA values were outliers. We calculated the values of the ROA indicator and from them we calculated the median values of return on assets in the regions in individual years.

Table 10. Median of ROA indicators of companies by regions in Slovakia

Median of ROA in %	Year	region_id							
		62	63	64	65	66	67	68	69
	2016	2,45	2,65	3,18	2,71	3,02	2,40	2,59	2,36
	2017	2,45	2,48	3,05	2,57	2,92	2,34	2,37	2,31
	2018	1,85	1,92	2,49	1,99	2,52	1,99	1,69	1,86
	2019	1,44	1,41	1,85	1,31	2,10	1,36	1,36	1,38

* 62-Bratislavský kraj; 63-Trnavský kraj; 64-Trenčiansky kraj; 65-Nitriansky kraj; 66-Žilinský kraj; 67-Banskobystrický kraj; 68-Prešovský kraj; 69-Košický kraj

The return on assets indicator tells us about the profit that the company earned from 1 euro of assets. Due to the large number of companies, we decided to point out the median values of return on assets. The median values are positive but low. We see that in none of the regions did the median value exceed 5 %. We can point out the fact that from 2016 to 2019 the values decreased in all regions of Slovakia which means that the return on assets gradually decreased, in some cases there could be a loss, ie the investment exceeded the profit. In 2016, the median return on assets was above 2 % in all regions and above 3 % in regions 64 (Trenčiansky kraj) and 66 (Žilinský kraj). In the following years, we observe a decline, while by 2019 these values were lower than 2 %, with the exception of region 66, where we record a median of 2.1 %. The highest decrease was recorded in region 65 (Nitriansky kraj) by 1.41%, the lowest decrease by 0.92% was in region 66.

We tested the values based on the Kruskal-Wallis test. The Kruskal-Wallis test is a nonparametric test, which we used for comparing all regions of Slovakia.

We have two basic hypotheses:

H0: There are no differences between regions.

H1: There are differences between regions.

We analyzed data for the entire period as well as individual years. There were differences between individual regions throughout the period and in individual years, which meant that we rejected the H0 hypothesis and at the 95% confidence level we

leaned towards the H1 hypothesis that there are differences within the ROA indicator between Slovak regions.

Table 11. Kruskal-Wallis test about the differences between regions of Slovakia

Sample 1- Sample 2	Adj.Sig. 2016-2019	2016	2017	2018	2019
62-64	0.000	0.012	0.238	0.006	0.330
63-64	0.000	1.000	0.751	0.266	0.109
62-66	0.000	0.000	0.093	0.000	0.002
63-66	0.000	1.000	0.476	0.054	0.001
67-64	0.000	0.220	0.135	1.000	0.007
65-66	0.000	1.000	1.000	0.185	0.005
68-64	0.000	0.739	0.155	0.002	0.335
69-64	0.000	0.001	0.004	0.009	0.026
67-66	0.000	0.030	0.069	0.424	0.000
68-66	0.000	0.138	0.080	0.000	0.007
69-66	0.000	0.000	0.001	0.001	0.000
65-64	0.003	1.000	1.000	0.739	0.271
69-65	0.004	0.048	1.000	1.000	1.000
69-62	0.079	1.000	1.000	1.000	1.000
69-63	0.108	0.176	1.000	1.000	1.000
62-63	1.000	1.000	1.000	1.000	1.000
62-65	1.000	0.615	1.000	1.000	1.000
63-65	1.000	1.000	1.000	1.000	1.000
67-62	1.000	1.000	1.000	1.000	1.000
68-62	1.000	1.000	1.000	1.000	1.000
67-63	1.000	1.000	1.000	1.000	1.000
64-66	1.000	1.000	1.000	1.000	1.000
68-63	1.000	1.000	1.000	1.000	1.000
67-65	1.000	1.000	1.000	1.000	1.000
68-65	1.000	1.000	1.000	1.000	1.000
68-67	1.000	1.000	1.000	1.000	1.000
69-67	1.000	1.000	1.000	1.000	1.000
69-68	1.000	1.000	1.000	1.000	1.000

Despite the fact that we found that there are differences between regions, we cannot consider this as a sufficient result to claim that there are differences between companies in Slovakia depending on their operation in the regions. For regions with a p-value lower than 0.05, it is assumed that there are statistically significant differences and thus we accept the hypothesis H1, with the strongest values being equal to zero. These differences were not found in all years in the same regions, with the exception of regions 69-64 (Košický and Trenčiansky kraj) and 69-66 (Košický and Žilinský kraj), which means that the region is not a strong predictor. The values of the Kruskal-Wallis

test (K-W test) when testing the diversity of regions were in many cases equal to 1.00. If the p value of the K-W test is equal to 1.00, we can say that there are no statistically significant differences between these regions [11].

To find out that the same differences in the same regions did not come out every year, we decided to test the region through classification and prediction algorithms to find out what role the region plays in classification and prediction for different financial indicators such as e.g., ROA indicator.

2.1 XGBoost Tree algorithm

One of the newer machine learning techniques is the XGBoost Tree algorithm, which we used to analyze whether the region is a suitable and reliable predictor in evaluating the effectiveness of companies. Tree highlighting is a very effective and very commonly used method of machine learning [12]. It is the method of highlighting / amplifying the tree that is found in various successful current applications. Due to its frequent use, the tree amplification method has been shown to provide the best results within many classification criteria, in a wide range of issues [13]. The most important factor in the success of XGBoost is its scalability in all scenarios. The system is ten times faster than other current solutions and is scalable to billions of examples in distributed or limited memory settings thanks to several important systems and algorithmic optimizations [14].

Within this model, we used the default settings, number boost round was 10, maximum depth 6, minimum child weight 1.0, maximum delta step 0.0, sub sample 1.0, Eta 0.3; Gamma 0.0; Colsample by tree 1.0; Colsample by level 1.0; Lambda 1.0 and Alpha 0.0.

To reduce the negative effect of overfitting in classification and prediction methods, we applied the model on both the training and test set according to the standard 80:20 distribution so that we could trust the model in terms of stability.

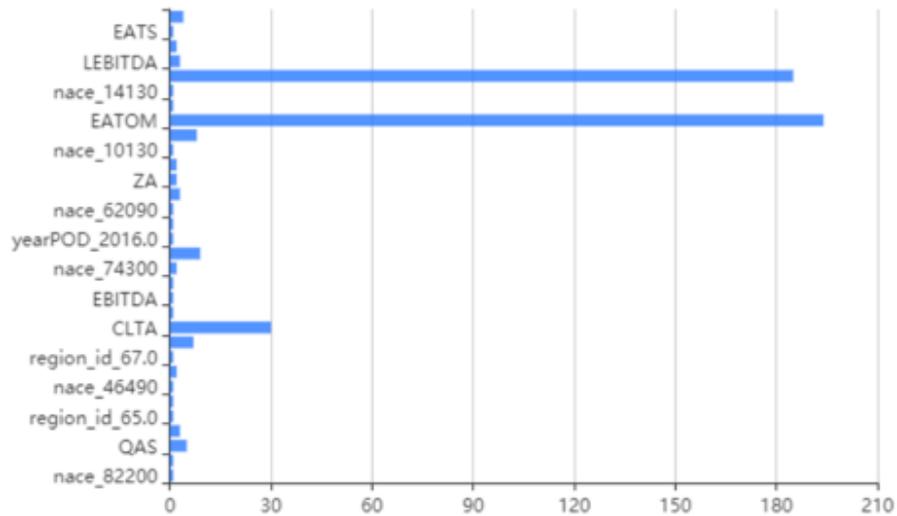


Fig. 2. Predictor importance with financial and social-demographic indicators

Within predictor importance, the region emerged as a significant predictor, but financial indicators were much stronger predictors. Among strong predictors of business efficiency, we include factors and indicators such as the industry, the region in which the company is located, EAT / S (net profit / sales), L / EBITDA (liabilities / EBITDA), EAT / OM (EAT / current assets), Z / A (liabilities / total assets), and QA / S (current assets / sales).

Table 12. Reliability of XGBoost Tree model

Partition	1_Training	2_Testing
Minimum Error	-17,647	-82,538
Maximum Error	12,295	15,59
Mean Error	-0,017	-0,022
Mean Absolute Error	0,046	0,054
Standard Deviation	0,173	0,544
Linear Correlation	0,998	0,977
Occurrences	149 236	37 563

In the training group, the accuracy of the created model was 0.998, but within the test group it was 0.977, which represents a high accuracy of the model, which means that sufficiently correct and important indicators were used in the model.

2.2 CHAID algorithm

Since the region also emerged as a significant predictor of financial indicators, we decided to use the CHAID decision tree algorithm to find out how strong a predictor is among socio-demographic indicators. The CHAID algorithm is based on chi-square statistics. The result of the test is a probability that is between 0 and 1. If the chi-square value approaches zero, there is a significant difference between the two classes being compared. If the value approaches to the one, it means that there is no significant difference between the two classes. CHAID is a segmentation method that can identify the relationship between a dependent variable and independent variables or predictors [15,16,17]. In addition to the region, we used the type of business ownership, the size of the business and the year as inputs. We used the default CHAID setting with an alpha of 0.05.

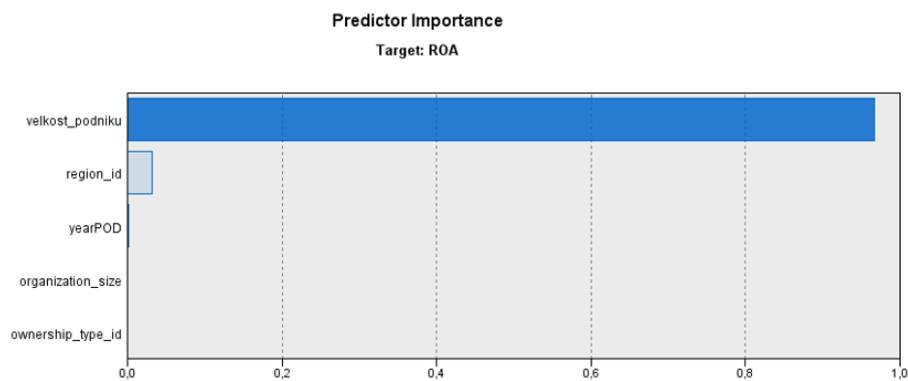


Fig. 3. Predictor importance of social-demographic indicators

Among socio-demographic indicators, the region is the second most important predictor at 0.03. In the CHAID decision tree (visualized below), other socio-demographic factors also play the most important role in micro-enterprises; in other types of enterprises, other socio-demographic factors also play an important role.

The created model of the decision tree CHAID in which the ROA indicator containing a sample of 149236 companies was divided in the first basic division according to the factor related to the size of the company into 3 branches with a p-value of 0.000. The Node 1 contained 30,203 companies, which was divided into two further branches Node 4 (27896 enterprises) and Node 5 (2307 enterprises) according to the type of ownership of the companies. For branch Node 5, the decision tree algorithm did not find a significant factor according to which the statistical significance should continue the division. However, the algorithm found a significant factor that can divide the Node 4 branch, depending on the year.

The Node 2 branch contained 70,614 data relating to micro-enterprises. This is the most numerous node, which further branches into 3 branches Node 6, 7 and 8 according to the organization size. For the Node 6 and Node 8 branches, the algorithm did not find a significant factor according to which they could be divided further, which means

that for them this division was final. However, for the Node 7 branch, a factor was found according to which it was possible to divide the dressage into the other three Node 13, 14 and 15 branches according to the type of region in which the company is located.

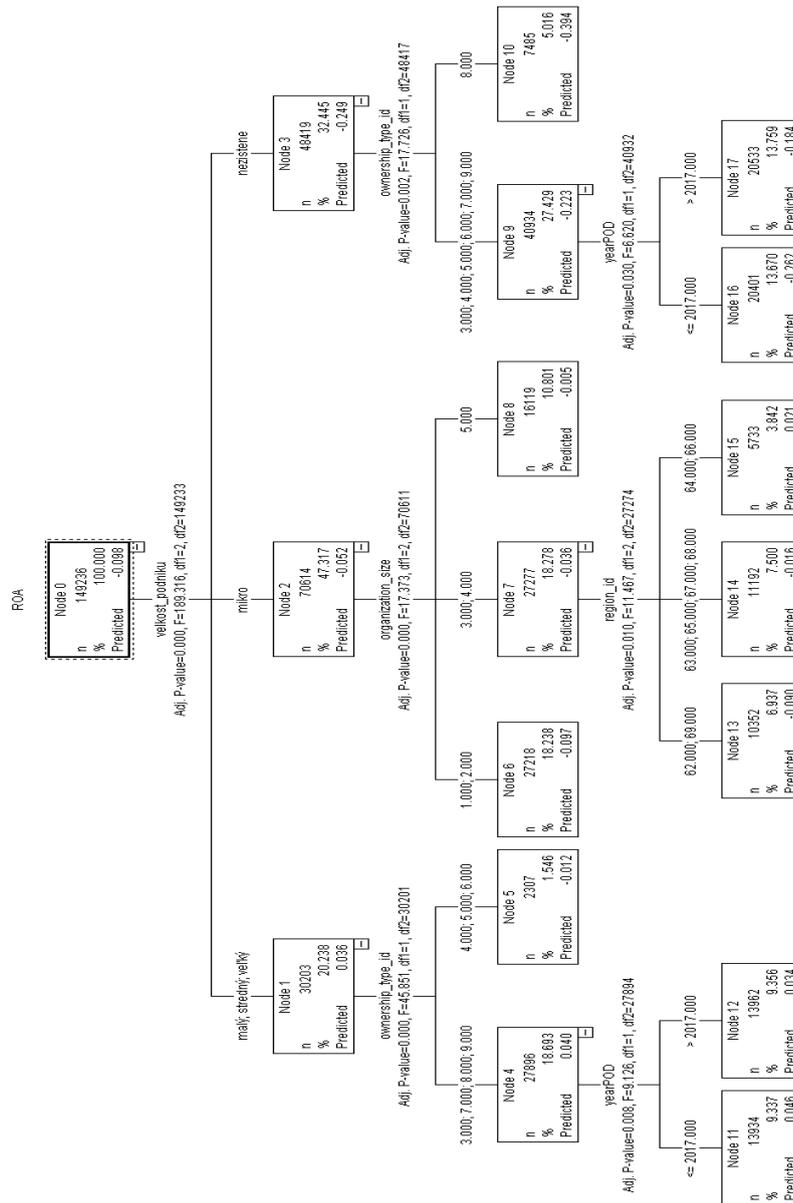


Fig. 4. CHAID Decision Tree of ROA indicators with social-demographic factors

The Node 3 branch, containing 48419 enterprises, contained enterprises whose size was not determined. This branch could be divided into two more according to the ownership type factor on Node 9 and 10. The Node 9 branch contained 40934 data, Node 10 only 7495, while the Node 9 branch was divided by the algorithm into two branches by year, according to the years on Node 16 (2016 and 2017 years) and on the Node 17 branch, containing data from 2018 and 2019.

The CHAID algorithm showed us the importance of the region as a factor that affects the efficiency of companies. The regional factor was also significant in addition to financial indicators, but among the socio-demographic factors we can consider it the second most important factor in the efficiency of individual companies.

Conclusion

We can define, measure and analyze the efficiency of a company through several ways and methods. This is due to the way we look at efficiency and what kind of company we consider effective, what values the financial indicators must acquire in order to be able to call a company efficient. At present, however, there are a number of opinions from different authors and a number of different studies on the latter we can rely on and create our own analyzes based on them. As part of the analysis, we decided to focus on the ROA indicator as a financial indicator and based on it, we analyzed the strength of the regional factor. Based on the performed analysis, we state that the region is a factor that has an impact on the efficiency of companies. Taking into account both financial and non-financial indicators and factors, the region came out as a significant factor, as its strength was not clear in addition to financial indicators, we decided to use CHAID decision tree to determine its strength in socio-demographic indicators, in this case as the second strongest predictor of business efficiency. The analysis was created on the basis of data on organizations in the time period 2016-2019, which represents the period before the outbreak of the COVID-19 pandemic. In further research, we will analyze organizations during a pandemic, the change of various financial and non-financial indicators, how the crisis affected their development, the organizations in which sectors of the economy were hit the crisis the most, which less and which not at all.

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Criteria for Fuzzy Rule-based Systems and its Applicability on Examples

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Abstract. Classification allows us to handle the large amount of data that is available nowadays. In our work, we use the classification features to divide employees into the several classes and examine the differences between the classical and flexible classification. We also emphasize the advantages of classical classification as well as the disadvantages, and how we can solve them by fuzzy logic. Fuzzy rule-based systems are explainable and therefore interpretable because the rules are defined by linguistic variables. Design of a more complex system is a tedious task. To resolve this, we examine interpretability criteria for fuzzy rule-based systems. We examine this topic on the examples with two classification attributes because it is easily illustrated graphically. To use more attributes is mathematically possible, but it is harder to visualize for users in a three and more dimensional spaces. In our work, we propose how to create an explainable design for classification and propose possibilities how to expand it.

Keywords: Fuzzy logic, Rule-based systems, Classification, Explainability.

JEL classification: C 4, D 8, C 9

1 Introduction

Classification splits large amounts of data into several predefined classes. It is used in many industries such as biology, medicine, geography, as well as in business, where it has found a great advantage in categorizing individual data, such as grouping products, customers, and employees [4]. Today, we recognize many classification methods, e.g., rule-based systems, fuzzy classification systems, Naive Bayes, and machine learning methods, which include neural networks and logistic regression.

Companies and institutions currently dispose with large amount of data and

information. In order to use this data effectively, we need to handle them correctly.

Rule-based systems classify data according to the defined rules provided by domain expert. Thanks to the users input, classification models are explainable and therefore easily interpretable, but with a more complex model, it is difficult to define consistent rules and input parameters. Methods based on learning procedures from the data have proven their efficiency, but for modeling the correct design, it is necessary to have a sufficient amount of data for learning and validation [13] as well as criteria to evaluate interpretability [10].

Explainability is the crucial factor in many systems, especially in the medical sector, but also in the economy, or in everyday life. Different classification systems help us to make decisions. They are an increasing part of our lives and therefore, it is very important to trust their outputs.

In our work, we examine important rules, summarized in [10], which should be considered during creating explainable and reliable rule-based systems, and propose how to deal with such issues.

The remainder of the paper is organized as follows. Section 2 briefly describes classification methods regarding explainability. Section 3 shows explainability and interpretability issues which should be considered. Section 4 is devoted to experiments. Section 5 discusses obtain results and the implications for the future research. Finally, Section 6 concludes the paper.

2 Classification Methods

Today, many algorithms focused on resolving classification problems exist. But the question stays, how we design a trustworthy system. In this section, we will shortly discuss features of rule-based systems and fuzzy rule-based systems.

Rule-based systems as well as fuzzy rule-based systems use IF-THEN rules to define a classification model [7]. The main difference is that crisp classification consists of precise values and sharp rules, whereas fuzzy classification uses fuzzy sets and fuzzy logic.

Crisp classification requires rules such:

- IF $x \leq Q$ and $y \geq P$ THAN good performance (G)
- IF $x \geq Q$ and $y \geq P$ THAN medium performance (M)
- IF $x \leq Q$ and $y \leq P$ THAN medium performance (M)
- IF $x \geq Q$ and $y \leq P$ THAN bad performance (B)

where P and Q are values of variables x and y , respectively. We can see this model on the Fig. 1.

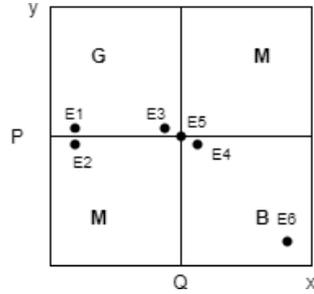


Fig. 1. Classification into three classes by four crisp rules.
Source: Own processing.

The problem of crisp rules can be seen on entities near the class's borders [8]. The entities *E1* and *E2* have similar entry values, but they are treated differently. The same applies for the entities *E3* and *E4*. On the other hand, the entity *E4* has significantly better performance than the entity *E6* and yet they belong to the same class.

As we explained, the classical classification might not guarantee us a fair classification of entities. One of the possible solutions is to divide the classification space into several additional classes, which would increase the complexity and reduce the transparency of the classification [9].

Fuzzy rule-based systems allow entity to belong to more than one fuzzy class. If corresponding values are similar for two entities, their membership functions are similar too. The fuzzy rules for classification into three classes with two attributes are as follows (see Fig. 2):

- IF *x* is high and *y* is low THAN bad (B),
- IF *x* is high and *y* is low THAN medium (M),
- IF *x* is low and *y* is high THAN medium (M),
- IF *x* is low and *y* is high THAN good (G).

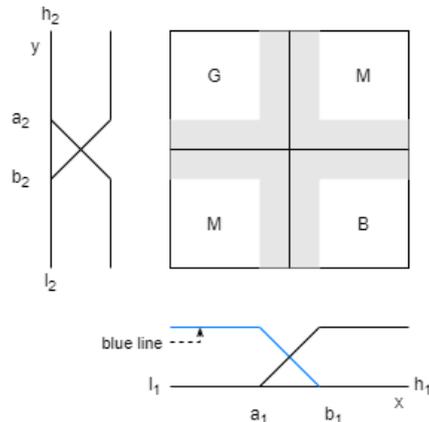


Fig. 2. Classification into three classes by four fuzzy rules.
Source: Adapted from [9].

Fuzzy rule-based systems better represent experts' requirements and the classification is fairer with the same number of rules. The possibility of using fewer rules is because the classes overlap, elements do not only belong to the set, but belong to the set with a certain membership degree [8]. There are no strict boundaries between classes, i.e., fuzzy logic ensures a smooth transition.

For the simplicity reason (which do not affect generality), the examples consider the afore-mentioned classification into three classes defined by two attributes.

Systems using rule-based classification achieve explainable and therefore easy interpretable results [7] [16]. Rule-based systems are interpretable, but there is a problem with constructing consistent rule-based systems and when required application in different areas for the same task. For instance, the afore mentioned rule base is self-explanatory, but the meaning of attributes differs among departments for the same product. For instance, selling air-condition equipment in Rome and Reykjavik.

In the next section, we describe possible problems which can occur and disturb the explainability. We show it on the examples of evaluating performance of employees.

3 Explainability in Fuzzy Classification Systems

This section demonstrates several key problems, which might appear during the construction of the classification space. To tackle this problem, Alonso et al. [10] have summarized the interpretability criteria.

Criteria for fuzzy sets include normality, continuity, and convexity. On the level of linguistic variables and fuzzy partitions, constrains are justifiable number of elements, distinguishability, and relation preservation among others. On the fuzzy rules level, criteria are description length and granular outputs. Finally, on the fuzzy rule bases level, criteria are consistency, average firing rules, completeness.

When a rule-based system is growing, these criteria become more relevant. In the next section, we look closer at the constraints and criteria.

3.1 Definition of Classification Space

The design of classification space should ensure normality requirements [10]. It means that at least one element should have full membership to the fuzzy set. When we define class, we should also identify element which represent that class as a prototype. Then, we compare real values with the prototype and classify accordingly.

When we design classification space, we also have to have in mind that each element should be represented at least by one fuzzy set. This is crucial, how we define the space and the boundaries. This is also connected with definition of leftmost and rightmost fuzzy sets, which represent the limit values of a classification space.

In Fig. 2 the leftmost fuzzy set for the attribute x is marked with blue. This fuzzy set represent the low values with degree equal to 1, which we should define as a prototype. Otherwise, it is not interpretable. The same approach applies for all defined fuzzy sets.

When we define rule-based systems, expert give us the rules at the beginning. For example: If the performance is good (higher then 600) than seller get the highest reward

(100). We see in the Fig. 1, that $E5$ is partially in the class good performance (0.5) so seller should get reward 50. As we can see, expert besides of the rules should also define the parameters. With a higher number of classes and classification attributes, it can be a tedious task. With high complexity of systems, it also becomes harder to maintain. In our classification space, the parameters which should be defined are marked as a_1, b_1, a_2, b_2 for input attributes, three parameters for output classes as well as the lowest values (l_1, l_2) and highest values (h_1, h_2) in the Fig. 2.

3.2 Classification Classes

Membership functions and classification algorithm should have continuous effect [10]. For example, if the employee is better, we evaluate him higher, or if the customer is more loyal then receives a higher discount.

The classification classes should be convex, i.e., we can identify how far is the item from the ideal value. It is difficult to label the non-convex set with linguistic term, which is key to explainability. In our example, we define several linguistic terms within one attribute: low - high, short - long, good - bad. In the Fig. 2, we can see two fuzzy sets which define attribute x and two fuzzy sets which define attribute y , and the result is union of these fuzzy sets.

The classes should be explicitly defined and ensure that the understanding between users is the same:

- All users agree on the implicit comparison of terms (bad < medium < good).
- Same width to all fuzzy sets – Differences might lead to improper classification (see Fig. 3).
- The sets should be well distinguishable.
- To ensure complementarity - sum of membership degree should be equal 1 [12].

The classified item can be part of more than one fuzzy set. In Fig. 1, we can see that $E5$ partially belongs to all classes. In this case, membership degree has to be 0.25 for each class. Otherwise, it would violate the continuity and the classification would be less fair.

The proof of this criteria can be seen on the next example:

In Fig. 3 are defined three fuzzy sets: low (L) < medium (M) < high (H). The reward in class L is 0 in class M is 50 and in class H is 100. We compare the results of values a_1, a_2, a_3 for the considered entities. The expected result is $a_1 < a_2 < a_3$.

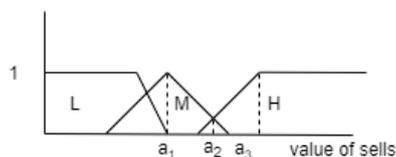


Fig. 3. Inconsistencies in defining fuzzy sets low (L), medium (M), high (H).
Source: Own processing.

- a_1 belong to classes (L, M, H) with membership degrees (0; 1; 0)

- a_2 belong to classes (L, M, H) with membership degrees (0; 0,25; 0,25)
- a_3 belong to classes (L, M, H) with membership degrees (0; 0; 1)

Rewards:

- $a_1 = 0*0 + 1*50 + 0*100 = 50$
- $a_2 = 0*0 + 0,25*50 + 0,25*100 = 37,5$
- $a_3 = 0*0 + 0*50 + 1*100 = 100$

The sum of membership degree is $0,5 \neq 1$ which cause the problem of unfair classification. As we can see, that the expected result and the actual result does not match: $a_1 < a_2 < a_3 \neq a_1 > a_2 < a_3$.

3.3 A Note to Using Software for Creating Classification Model

Software helps us to create classification models. For example, MatLab is a programming platform providing possibility to analyze and design systems and products. MatLab is the computing environment for engineers and scientists, but it is not often used in companies.

Commonly used software is MS Excel. Microsoft Excel is a part of the Microsoft Office tools. It is a spreadsheet program. Mostly used to create tabular forms, create specifying calculations, or for further graphical processing. It is a very useful and frequently used tool in many areas.

Another possibility of creating classification model is by using the Python programming language. In contrast to MatLab, Python is a general-purpose programming language. It is universal, suitable for creating applications for data analysis. Among other things, Python provides us with the advantages of fast processing as well as large volumes of data and simple programming syntax [11].

Using software provide us possibility to check syntax side of the classification problem but not the semantic. What we code to the program, it will compile that way. It is why we should be very careful with creating a reliable design.

4 Examples on Data

In this section, we introduce two examples, where the criteria from Section 3 are considered.

4.1 Evaluation of Employees – Applicability of Different Parameters

A hypothetical organization has departments in different part of the world where managers evaluate workers considering local specifics of regions where sellers operate by a universally accepted model. Managers wish to provide bonuses for sellers by two attributes: turnover and persuasion time.

The rule base is as follows:

- IF turnover is low AND persuasion time is high THEN reward is low.
- IF turnover is low AND persuasion time is low THEN reward is medium.

- IF turnover is high AND persuasion time is high THEN reward is medium.
- IF turnover is high AND persuasion time is low THEN reward is high.

The number of rules and linguistic variables is low, creating the base for an interpretable rule-based system and transferable to other departments. Generally, Takagi-Sugeno-Kang (TSK) rule-based systems are less interpretable than Mamdani rule-based systems, due to linguistic interpretation of the output attribute. But, when we create a zero-ordered TSK, it becomes interpretable for domain experts.

We transform rules to the structure:

- IF turnover is low AND persuasion time is high THEN reward is 0.
- IF turnover is low AND persuasion time is low THEN reward is p .
- IF turnover is high AND persuasion time is high THEN reward is p .
- IF turnover is high AND persuasion time is low THEN reward is m .

In this structure 0, p and m ($m > p$) are, e.g., money units. For instance, when $m = 50$ and $p = 100$, the fourth rule is activated with 0.6 and third rule with 0.4, the reward is between 50 and 100. It is a flexible solution and easily applicable in any data processing tool like broadly used MS Excel in offices.

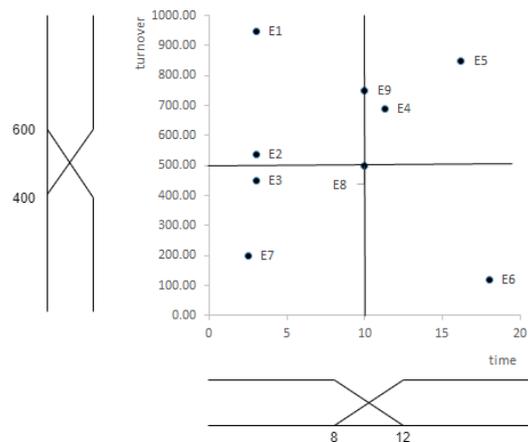


Fig. 4. Classification space for evaluating the employees.
Source: Own processing.

When the requirements of normality, convexity, relation preservation, justifiable number of linguistic terms, distinguishability, etc. is met, the rule-base is as depicted in Fig. 4.

Parameters of fuzzy sets in Fig. 4 can be assigned by managers in each department or mined from the data. In the latter, we can e.g., adopt uniformly divided domains and calculate parameters by the method proposed in [15].

The motivation is a key aspect in improving performances [6]. In our case, motivation should be based on sellers' results and the environment in which seller operates.

Table 1. Results for 1. department.

ID	TIME	TURNOVER	μG	$\mu M1$	$\mu M2$	μB	REWARD
E1	3	947.00	1	0	0	0	100
E2	3	537.00	0.685	0	0.315	0	84.25
E3	3	450.00	0.25	0	0.75	0	62.5
E4	11.3	689.00	0.175	0.825	0	0	58.75
E5	16.2	850.00	0	1	0	0	50
E6	18	120.00	0	0	0	1	0
E7	2.5	200.00	0	0	1	0	50
E8	10	500.00	0.25	0.25	0.25	0.25	50
E9	10	750.00	0.5	0.5	0	0	75

Source: Own processing.

For one department parameters for turnover might be 0, 400, 600, 1000 (see Fig. 4), whereas for another department are 0, 700, 800, 1200, i.e., selling air-condition is less demanding in, for instance, Rome than in Reykjavik and moreover, the population in Reykjavik is significantly lower. In business applications, mixture of constructing rule - based system from experts and adjusting to data in diverse regions is the option which should be considered. Anyway, the subset of the interpretability criteria (relevant for this task) should be met.

In the Table 1, we can see those values of both attributes of *E8* are in the middle of boundaries (400, 600) and the reward is the medium (50). *E9* gains higher reward because the value of γ attribute is also higher. In the Table, the parameters for attribute turnover are different (i.e., (700, 800)) and therefore *E9* having the values 750 is in the middle of the defined boundaries. It causes that the reward is now medium (50), whereas *E8* gains lower reward. The persuasion time stays the same for both departments also the boundaries, so it does not affect the results.

Table 2. Results for 2. department.

ID	TIME	TURNOVER	μG	$\mu M1$	$\mu M2$	μB	REWARD
E1	3	947.00	1	0	0	0	100
E2	3	537.00	0	0	1	0	50
E3	3	450.00	0	0	1	0	50
E4	2.5	200.00	0	0	0.175	0.825	8.75
E5	16.2	850.00	0	1	0	0	50
E6	9.2	865.00	0	0	0	1	0
E7	11.3	689.00	0	0	1	0	50
E8	10	500.00	0	0	0.5	0.5	25
E9	10	750.00	0.25	0.25	0.25	0.25	50

Source: Own processing.

4.2 Evaluation of Employees – Easily Interpretable Model

In the example of evaluation of employees, our main purpose is to create easily interpretable model for employer/manager as well as for employee. The model can be extended for more attributes, but we could not represent results graphically. Two-dimensional space is easily readable and give us immediate insight into the results. For example, in the Fig. 4, we see that employee *E2* should increase the value of turnover. Contrary, *E9* has to decrease the persuasion time, whereas *E6*, and *E8* should

improve in both classification attributes.

When using more attributes not only that we cannot easily visualize the results but also, we should consider possible correlations and so-called coalitions among atomic conditions. For example, the simultaneous occurrence of attributes A, B, C is less significant than the occurrence of A, G. Such a situation is captured by the Choquet integral [1], which also becomes an object of interest for an explainable classification.

5 Discussion

In this work, we examined interpretability criteria for rule-based systems and illustrated on an example related to selling the same item in different regions.

To compute the interpretability of a model is a hard task, as the definition of interpretability cannot be formulated in strict mathematical sense. It also involves the human factor, which is hard to formalize [10]. For instance, in our example the criterion of unimodality is not relevant, or in some other applications it might be less important than the other. In this work, we evaluated a subset of explainability criteria relevant for our examples. The other criteria are examined in [10].

An interpretable rule-based model, like the model for reward explained in this work, can be used among departments. The only adoption is in adjusting parameters to the environments in which sellers are operating. The same holds for using the rule-based model in different time frame, where economic growth and crisis (like the current pandemic situation) appears.

An oversimplified option is to have a list of the interpretability criteria and mark the filled ones. A more reliable option is aggregating atomic criteria. But, it is not an easy task. In a conjunctive aggregation if a single criterion is not met, the interpretability degree is equal to 0. Contrary, in a disjunctive aggregation a single met criterion ensures the full interpretability. Hence, an option is quantified aggregation of atomic attributes [14], where interpretability increases as the number of met criteria increases. On the other hand, in various tasks several criteria might be mandatory, whereas other optional, which leads us to the asymmetric conjunction proposed in [2] and fully axiomatized in [5]. The future tasks should evolve around aggregating elementary interpretability criteria summarized in [10] and for additional ones like dominance of rules.

6 Conclusion

We examined explainability in fuzzy rule-based systems. These systems are generally

explainable, but with an increased complexity, inconsistencies might occur.

In example we discussed criteria which we should have in mind during creating a classification space in order to develop a reliable design. Fuzzy rule-based systems bring us a fairer classification, but it should be consistent.

We can use our results wherever we want to evaluate similar entities similarly. This means, that the boundaries of sets are not expressed by an exact number, like” about, around, much, little, etc.” Therefore, we replace sharp set with a fuzzy set, which describes the statement more realistically, leading us to the fuzzy classification. Management applications and databases from individual departments and divisions within the company provide us with quantitative as well as qualitative performance indicators, from which we can obtain the data and subsequently create an application of fuzzy classification. Such application provides various analyzes for the company [8]. By using conceptually described models, we can easily solve practical examples. The model can be reused by adaptation to changing data and parameters over time and in different areas.

The explainability and interpretability are important features for the systems, whenever we want to trust the output. In our examples, we used two classification attributes to make the output easy to read and also easy to visualize graphically. In practice, a large number of attributes can be used, but to meet all criteria is a more demanding task.

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Impact of Corona Crisis on Economic Development and the Situation in the Financial Sector of the Insurance Industry

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Abstract. The insurance industry has become one of the most important sectors of the national economy in the last decade and is actively involved in the functioning of the market economy. It interferes with the lives of citizens, the state, business entities and also plays a significant role in international trade. The insurance market is constantly evolving and adapts to the needs and requirements of insurance entities, as well as relevant legislation. Its importance for citizens and businesses is unquestionable. It helps them maintain a standard of living and economic stability and, in addition, gives them the opportunity to invest temporarily free funds. It is part of the financial market, which is affected by various risks, which certainly include the period of coronary crisis. In this paper I will examine how the corona crisis until 2020 affected the insurance industry.

Keywords: insurance, coronavirus crisis, risk, insurance

JEL classification: G20, G21, G22

1 Introduction

The current insurance industry can be considered a relatively developed sector of every national economy in Europe. Historical development of insurance was closely related to the development and needs of human society. Observing uncertainty and risk, they began to seek to minimize the potential impact of these risks. It was precisely uncertainty and risk that led to the creation of insurance, and thus to the creation of a separate branch that deals with insurance.

According to the latest annual report of the NBS (2019), 14 insurance companies with registered offices in the Slovak Republic operated on the Slovak financial market under the Solvency II regime. As at 31st December 2019, one insurance company ceased to exist as a result of a merger with another insurance company. During 2019, one insurance company ceased its activities, and its insurance portfolio was transferred to another insurance company. In 2019, there were 20 branches of insurance and reinsurance companies based in another EU Member State on the territory of the Slovak Republic. According to the NBS, the slowdown in the global economy continued in 2019 during the financial market, the first signs of which began to materialize in the previous year. The economic environment was accompanied by growing risks stemming from global uncertainty from the effects of the trade conflict between the world's two largest economies (the United States and China) and the course of negotiations on the United Kingdom's withdrawal from the EU.

The decline in production mainly affected the industrial sector, which paid for the reduced demand for investment products. The absence of foreign sales hampered industrial production in particular - it has been declining continuously on a year-on-year basis since the end of 2018. Slovakia, like most EU countries, was at the peak of its growth phase and its growth rate slowed down considerably. The cooling world demand thus gradually ended the expansion phase present in the recent period in most European countries. The development of the economies of trading partners, especially Germany, on which Slovak exports depend, had a negative impact on the Slovak economy. The consumption of Slovak households continued to grow due to the continued favorable development of the labor market and the strong growth of the average wage, but its contributions to economic growth were no longer as strong as in previous years.

In 2019, the financial sector of insurance companies faced several long-term risks. The first risk is lower-than-expected asset returns, as a result of which insurance companies have been forced to close reserves. This had a negative effect on their profitability. The second risk is a new tax in the non-life insurance segment, which reduces profits and, in some segments, client demand, which has slowed down premium growth. This further highlights the problem of long-term loss of car insurance. A significant structural risk is that a large part of own funds is formed by the volatile component of expected profits from future premiums, which cannot effectively cover possible sudden unexpected losses. Although the share of this component has decreased slightly, it remains the highest in the EU.

According to the analysis of OVB Allfinanz Slovensko, in 2020 the Slovak insurance market fell by 3%. That's according to a study by the Allianz Group. According to them, this negative development can be fully attributed to life insurance, which represents only 40% of premium income and fell by as much as 10%. On the contrary, insurance in the property segment increased by 2.4% and the reason could be the price competition.

2 Methodology

This paper evaluates the impact of the coronavirus crisis on economic development and the situation in the financial sector of the insurance industry. To obtain the necessary information and data, a survey method was used through statistical data obtained in the Slovak Insurance Association and their comparison with the period before the coronavirus crisis. Data for written premiums, including active reinsurance for all insurance companies and branches in the Slovak Republic, and claims incurred were used for comparison and analysis. The result is the Technical Result, which, by comparing the years 2019 and 2020, shows how the insurance company managed claims in its portfolio during the crisis. The financial result talks about how insurance companies handled reserves and how they were able to increase their value, and combined result talks about the percentage of non-life insurance and active reinsurance contributing to this result. Comparing the years 2019 and 2020, we will find out the impact of the coronavirus crisis on economic development and the situation in the financial sector of the insurance industry.

3 Current situation in the financial sector of the insurance industry

The insurance market is a special type of market in which supply and demand in the field of insurance and reinsurance take place (Majtánová, 1998). Insurance as a non-productive sector of the national economy is one of the most important sectors of each state. They are part of the financial market, located as a special branch of financial services that are provided to businesses, citizens and companies. The importance of insurance lies in the fact that it helps to stabilize the economic situation in society and creates new job opportunities (Meluchová, 2000). If the economy is balanced and successful, then the insurance market is also credible. Developments in the insurance market are leading to greater complexity of services and new forms of communication with the client. The globalization of the world economy facilitates the achievement of these goals, but multiplies the risks. The financial market represents a system of economic relations and institutions mediating the allocation of free funds (Koščo, 2002). In terms of individual segments, the financial market is divided into:

- Money market,
- Capital market,
- Foreign exchange market,
- Commodity market - market with precious metals and other commodities,
- Insurance market - insurance and reinsurance market.

The financial market can be broken down according to different aspects and criteria (Figure 1). Each division of the financial market is always a certain simplification and does not allow to include the financial market in its complexity and interrelationships. We encounter the division of the financial market with several authors, such as Kudzbel (1999), Čejková et al., (2002), Majtánová (2009). According to the mentioned

literature, we distinguish the financial market from two points of view - in terms of time and in terms of a segment. According to Kudzbel, we can define the insurance market as follows:

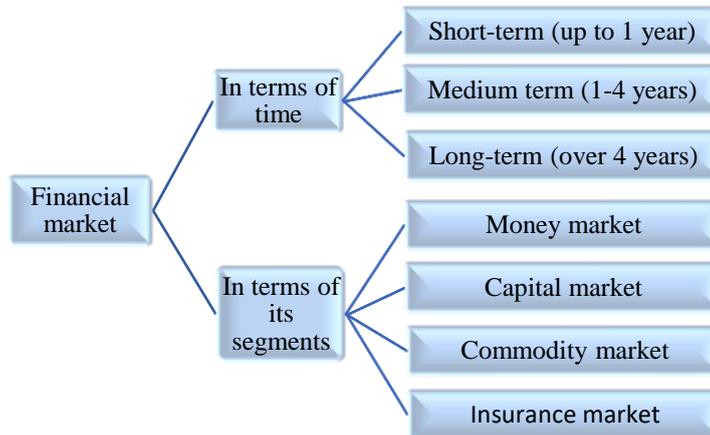


Figure 1 Financial market breakdown

Source: Own processing

The basis of insurance is the objective existence of risk. Reducing this risk should be a natural human endeavour. If we understand the population as the basic subject of the insurance market, we will find that insurance is at its lowest level on its personal scale of consumption. It should be emphasized that the ratio of life and non-life insurance in the developed EU countries is approximately the same. The situation on the world insurance market is influenced by the processes that determine the state of the world economy. At present, it is a relatively high rate of overall economic growth, accelerating international trade in goods, increasing production capacity and expanding the purchasing power of the population. The activity of insurance markets in developing countries is also increasing, but above all the situation on national insurance markets in the most developed countries of the world. The characteristic determinants of the world insurance market are:

- Further development of insurance,
- The ongoing process of capital concentration,
- Ongoing internationalization of insurance.

The insurance market can be defined according to the subject of business, the subject of insurance and reinsurance or according to the entities that influence it. The subject of insurers' business is insurance activity, reinsurance activity, preventive measures, broker activity and insurance-related activities, which serve to support and develop the insurance industry as well as to expand and improve insurance services. Insurance activity includes underwriting business activity, which consists in negotiating insurance contracts; administration of concluded contracts and collection of premiums on the basis of concluded insurance contracts; liquidation activity, the aim of which is to determine the size of claims incurred, valuation of damages, determination of size

claims and the payment of claims and the actuarial and technical activity, which includes the determination of the size of premiums and the size of insurance reserves. Reinsurance activity represents the vertical spread of risk in connection with risk diversification. By preventive activity we mean the prevention of damage. This is carried out by prefinancing individual preventive measures from the funds of the damage prevention fund, educational activities leading to the limitation of risk realization or by various elements in the construction of certain types of insurance (Vávrová, 2013). According to the subject of insurance and reinsurance, the insurance market is divided into life insurance, which is focused on the risk of survival or death, and non-life insurance, which is focused on various risks in property and liability insurance. Entities influencing the insurance market are commercial insurance companies, clients (policyholders and insured), reinsurance companies, insurance and reinsurance intermediaries, the state, insurance supervision, associations and other insurance market entities (Čejková et al., 2011).

The investment insurance market operates in such a way that insurance companies invest their technical provisions in the financial markets. Life and pension insurance is usually associated with a long-term savings process and therefore the means of technical provisions are suitable for long-term investment in the capital market. Provisions in the non-life insurance sector, on the other hand, are associated with a short period of time in which they must be liquid (Vávrová, 2013).

We can divide the insurance market according to several criteria. The decisive criterion for division or segmentation is the subject of the insurer's activity, others may be insured risks, the subject of insurance, insurance products, insurance subjects, insurers and the like. The basic segmentation of the insurance market is shown in Figure 2 (Čejková, Nečas, 2008).

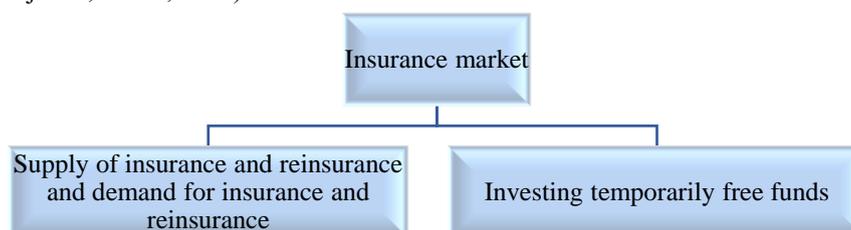


Figure 2 Basic segmentation of the insurance market

Source: Own processing according to (Čejková, Nečas, 2008).

Developments in the insurance market are influenced by several determinants. We can define them as external and internal.

External determinants affect developments in the external insurance market and include mainly the development and volume of gross domestic product (GDP), inflation, unemployment, population number and structure, life expectancy, breakdown into men and women, etc., monetary income of the population, or average wage, volume of household income and expenditure and their structure and situation in other segments of the financial market. Basic macroeconomic variables such as the development and volume of gross domestic product, the development of monetary

income, inflation and the development of unemployment affect the economic environment in which insurance and reinsurance companies operate and operate, and thus the activities and behaviours of insurance market participants. The population, the monetary income of the population as well as the amount of income and expenditure of households allow insurance and reinsurance companies to better estimate the scope and possibilities of their business or to adapt to the specifics, needs and insurance interests of the population. The situation in other segments of the financial market mainly affects the investment of free funds of insurance companies in the financial market and often has a significant impact on the state of management of insurance and reinsurance companies (Čejková et al., 2011).

Internal determinants influence developments in the insurance market from within and include mainly insurance, reinsurance and other related activities performed by commercial insurance and reinsurance companies, interest in insurance created by policyholders and policyholders, understanding of the importance of insurance by clients, insurance market regulation by insurance supervisors, the activities of insurance and reinsurance intermediaries and the activities of various associations. By the activity performed by insurance companies on the insurance market, we primarily mean offering and selling insurance. Reinsurers, in turn, enter the insurance market if insurers show interest in reinsurance. They therefore divide the existing risks into more entities, thus expanding the capacity of insurers. The supervisory authority shall issue an authorization to entities to carry on insurance and reinsurance activities, thereby carrying out its main, authorization activity. In addition, it monitors compliance with laws and legal norms, thus protecting the rights of policyholders. Intermediaries in the insurance market are an intermediate link between the insurer and the insured, resp. policyholder. They also provide their clients with services in the area of risk management, consulting, etc. Associations of insurance companies, insurance and reinsurance intermediaries and other associations represent their members, protect their interests and rights (Čejková et al., 2011).

The level of the insurance market can be characterized by several indicators that assess the efficiency of the use of resources and funds spent. These include, in particular, written premiums, claims incurred, claims paid, insurance market penetration and insurance market density (Čejková et al., 2005).

Premiums written, which means premiums that are set for the agreed insurance period or for the entire insurance period. It is an accounting list of all premium items that are to be paid to the insurance company at a given time. It is an indicator of the performance of each commercial insurance company for the relevant period and its amount determines the insurance company's share in the insurance market of the respective state and, after deducting costs, represents the basis for calculating the insurance company income tax. Premiums written are divided into life insurance premiums and non-life premiums written (Čejková et al., 2005).

The indemnity is calculated and provided by the insurance company for compensation of damage, claims paid, or part of the damage caused as a result of an insured event in non-life insurance or the agreed sum insured in the policy, the purpose of which is to obtain this amount. The insurance company is obliged to provide the insurance indemnity to the insured or the injured party in the event of an insured event

that meets the conditions agreed in the insurance contract, or specified in the law (Vávrová, 2013). We divide it into insurance benefits for life and non-life insurance. In the case of non-life insurance, it is not certain whether a premium will occur event, resp. how many times it occurs, but the insurance indemnity is provided only in the event of its occurrence (Vávrová, 2013).

The claims ratio represents the ratio between the amount of provided insurance indemnity and the amount of written or received premium. It is given as a percentage. It should be lower than the net premium (part of the premium tariff, which is intended to cover the insurance company's expenses for insurance benefits, including the creation of reserves) (Ducháčková, 2015) in percent and should not reach the full amount of premiums received (Vávrová, 2013).

Insurance penetration is one of the most important indicators of the development of the insurance market. It expresses the ratio of written premium to gross domestic product. It is also expressed as a percentage and in advanced economies it expresses the capacity of the insurance market. The total possibility of insurance on a given insurance market is given by the scope of the insurance field. An insurance field is a set of property, objects, persons or other phenomena existing in a given state or territory that can be insured and the insurance policy reflects the ability of the insurance market to cover the given field (Vávrová, 2013).

Insurance market density represents the share of the largest commercial insurance companies (usually five or ten) in written premiums. It is usually monitored for the 5, 10 and 15 largest insurance companies in the affected market (Vávrová, 2013).

We also know additional indicators, which include in particular the number of commercial insurance companies (indicates the development and maturity of the insurance market and the method of its regulation), number of employees in insurance, number of insurance contracts, average premiums per insurance contract, number equipped insurance events, etc. (Vávrová, 2013, pp. 38-39). The number of commercial insurance companies can document not only the development and maturity of the insurance market, but also the way it is regulated by the state. The number of employees in the insurance industry informs us about the level of the insurance market in terms of its staffing and human resources. The number of concluded insurance contracts expresses, among other things, the efficiency of commercial insurance companies, the average indemnity per insurance contract expresses the average indemnity of a commercial insurance company per insured event and the number of settled insured events expresses the final effect of insurance and thus the settlement and payment of the amount. the injured party is entitled under the concluded insured contract (Čejková et al., 2011).

4 Results and Discussion

The coronavirus crisis significantly affected economic development and the situation in the financial sector. The most significant event in the first half of 2020 was the outbreak of a coronavirus pandemic, which also hit Slovakia hard. Massive restrictions have been adopted to slow its spread. These restrictions have caused a sharp economic

downturn and a deterioration in the financial situation of many households and businesses. In the insurance industry, the coronavirus crisis was manifested mainly by a decrease in premiums written in life insurance, a decrease in the financial result and a reduction in the cost of claims in both life insurance and motor insurance. The development of written premiums for the period from 2016 to 2020 (according to SLASPO) is presented in Figure 1.

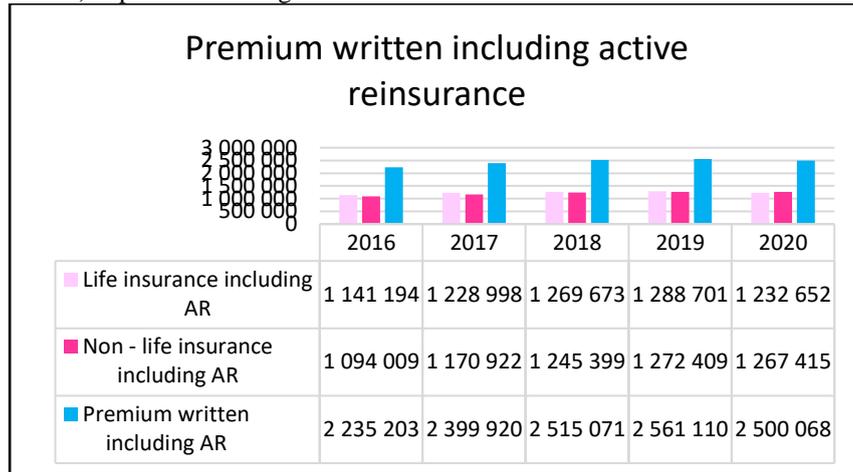


Figure 1. Gross premiums written 2016 - 2020

Source: Own processing

Total written premium decreased by 2.37% in 2020, which was mainly caused by a decrease in life insurance (-4.35%).

Graphically, the development of claims costs for the period 2016 to 2020 is shown in Figure 2.

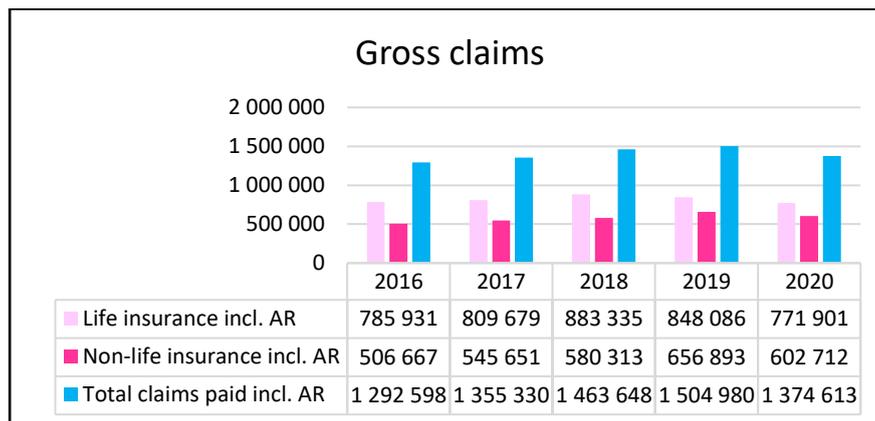


Figure 2. Gross claims 2016-2020

Source: Own processing

The technical result reveals how the insurance company managed to manage. It therefore represents the difference between the premiums received and the claims paid, together with other costs. Graphically, the development of claims paid for the period 2016 to 2020 is shown in Figure 3.

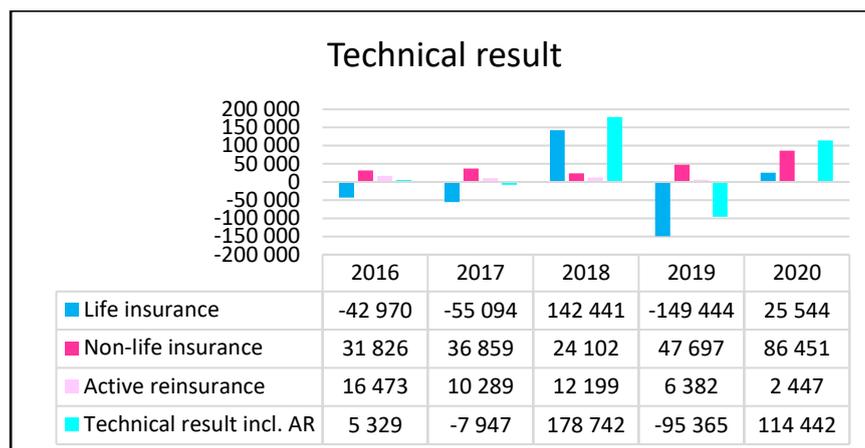


Figure 3. Technical result of insurance companies for the period 2016 to 2020

Source: Own processing

Graphically, the financial result of insurance companies for the period 2016 to 2020 is shown in Figure 4.

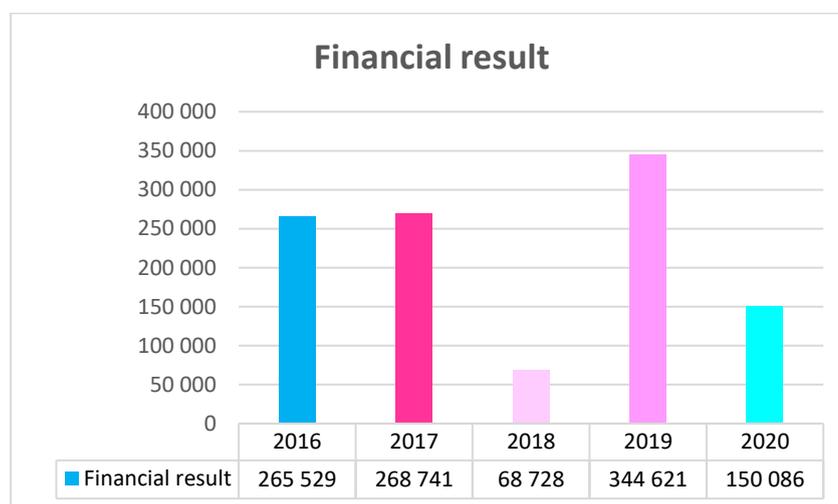


Figure 4 Financial result of insurance companies for the period 2016 to 2020

Source: Own processing

The financial result represents how insurance companies handled reserves and how they were able to evaluate them. According to Table 7, the financial result in 2020 is 56.45% lower than in 2019.

Graphically, the combined result of insurance companies for the period 2016 to 2020 is shown in Figure 5.

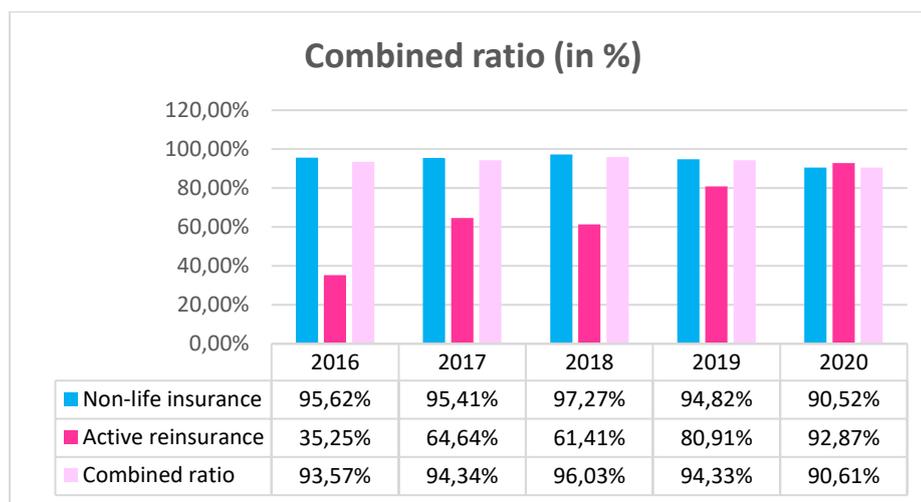


Figure 5. Combined result for period 2016-2020

Source: Own processing

The combined result talks about how non-life insurance and active reinsurance contributed to this result. According to Table 8, the decrease in the combined (-3.93%) indicator is due to a decrease in non-life insurance, which is 4.53% lower in 2020 than in 2019.

5 Conclusion

Insurance is an important sector of the economy especially in developed market economies. Therefore, observing its development becomes essential not only for entities operating in the insurance market, but also for entities operating in other segments of the financial market. Its development also substantially affects those interested in insurance and therefore not only corporate but also retail clients and thus has a certain impact on all market subjects.

In 2020 the insurance industry collected less written premium than in the previous period, but overall, it was more profitable. This is shown by the data of the Slovak Association of Insurance Companies (SLASPO) provided in this contribution. However, the insurance industry generated a profit of more than EUR197.7 million in Slovakia last year. In 2019, the profit of insurance companies, reinsurance companies

and branches of insurance companies reached less than EUR 182.7 million. The increase of taxed profit by around fifteen million euros means its increase of 8,25 %.

Insurance companies have significantly improved the results of insurance itself. The technical result of the insurance came to positive figures in 2020, when the sector generated a profit of EUR 114.4 million in this case. Non-life insurance contributed more than EUR 86 million to this result.

Based on the above, it can be concluded that the corona crisis has an impact on companies in Europe, including Slovakia, facing a decrease in their business revenues as a result of the coronavirus pandemic. However, the crisis did not affect all companies equally, with only 54% negatively affected. This was shown by Euler Hermes' survey, which was carried out among European clients at the end of the summer in order to obtain key information on the evolution of their turnover. Up to 20% of customers said their business was not affected at all and 19% even achieved an increase in sales.

However, it has been observed that insurers are reducing or eliminating any potential coverage for pandemic risk in property damage and business interruption policies. This creates a room to discuss the ability to transfer risks to the financial market and the of the government.

Based on the analysis, it can be concluded that the corona crisis, so far, has not impacted the insurance industry in the Slovak Republic substantially.

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Risk management of the leasing company

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Abstract. The number of leasing clients in Slovakia is constantly growing and this sector is becoming an increasingly important part of the local economy. Leasing as such ensures its financial stability, and the leasing companies themselves have changed from medium-sized companies to strong institutional investors who accumulate temporary free funds and place them on the financial markets. The management of potential risks that could jeopardize economic performance and stability must therefore be an essential part of their internal processes and must be given adequate attention. Under the pressure of competition and with the aim of profit, leasing companies also involve modern optimization methods in decision-making, and these become an integral part of business analysis. This work focuses on the potential use of one of the most widely used computational techniques in examining the risk of payment failure of their clients. By discriminatory analysis, we will verify the solvency of clients on the examined sample and then predict the probability of their future non-payment.

Keywords: credit scoring, discriminant analysis, leasing, risk management

JEL classification: *G11, G32*

1 Introduction

The leasing industry as a part of the financial sector represents a wide space for the application of heuristic methods and computer technology. Some of the areas, e.g. damage studies or estimates of interest rate developments have unique features in the industry, while customer classification, insolvency prediction or specific risk modeling are common research subjects for all firms, regardless of business. The considerable potential and achievements of these methods cannot be ignored, and for this reason we focus in this work on the use in the prediction of a relatively neglected, yet one of the most important factors in providing leasing, the risk of non-payment by clients. Many innovative methods have been developed in recent decades, which have found application, for example, in business (eg Alon et al. 2001; Kaefer et al. 2005), financial

markets (eg Bildirici and Ersin, 2009; Enke and Thawornwong, 2005; Eakins and Stansell, 2003) or banking (eg Celik and Karatepe, 2007; Abdou et al. 2008; Mostafa, 2009).

The original idea in the development of credit risk analysis was to use statistical tools on a sample of historical data in order to facilitate the decision-making process in selecting a suitable business partner and customer. In particular, banks have long had screenings of their loan applicants and lengthy data reviews. However, the massive rise of artificial intelligence and the availability of advanced computing in the 1980s marked the rise of sophisticated risk management techniques in general, including credit risk. Improvements in this area have enabled financial institutions to allocate capital more efficiently and to create new means of preventing, sharing and trading in this type of risk, such as credit derivatives.

Trinkle and Baldwin (2008) focused on creating an easy-to-interpret credit model, while Khasman (2010) tested several types of networks and learning algorithms to achieve the best possible predictions. Atiya (2001), Piramuthu (1999) and Tsai and Wu (2008) used the classification ability to develop effective methods for corporate credit ratings. The last group of authors tried to solve some shortcomings by presenting a combined system that integrates networks and fuzzy logic. Wu and Wang (2000) focused their attention on small American companies and deciding on their loan applications. They separated individual applicants according to set criteria and then compared their results with information from regional banks on loans granted and rejected. The authors came to the final conclusion that the new methods surpassed conventional types of credit risk analysis in the form of classical regression and logistic models. On the other hand, Bensic et al. (2005) successfully investigated small business loans in transition countries with the help of networks and decision trees.

One of the main economic areas where the risk of default plays a significant role is consumer loans. West (2000), Malhotra and Malhotra (2003), Xiao et al. (2006) or Šušteršič et al. (2009). Using artificial intelligence algorithms, Khandani et al. (2010) several nonlinear nonparametric models for predicting consumer credit risk. The calculations were based on data from US commercial banks on small loans provided from January 2005 to April 2009. By applying these techniques, the authors report a reduction in losses from intentional and unintentional payment default of up to 25%.

An inseparable part of understanding credit risk are its indicators published by international agencies, the so-called credit ratings. In an effort to contribute to the transparency and efficiency of financial markets, Bennel et al. (2006) their explanatory value and compared the results obtained by neural networks with the probit model. Huang et al. (2004) and Jiao et al. (2007) combined traditional types of networks with known heuristic procedures when examining credit ratings, while Hájek (2011) assessed the creditworthiness of smaller US municipalities. Other applications of heuristic methods and artificial intelligence in credit risk analysis can be found in Yu et al. (2008).

However, in addition to industry-specific risks, leasing companies, as businesses, are exposed to another group of risks, typical of all companies in a market environment. Among others, these are mainly strategic risk, market risk, operational risk and legal environment risk. These concepts are common in business practice and are precisely

defined, for example, by Alexander and Sheedy (2005). However, as already mentioned, the subject of research of this work is the risk that the other party to the contractual relationship will not meet its obligations and will not make a pre-agreed payment, i. credit risk. There are several definitions of credit risk, including from Colquitt (2007) which states that, "... credit risk arises when a creditor is exposed to a possible loss from a counterparty ...". Nason (2010) describes credit risk as "a potential gain or loss due to a change in the debtworthiness of a customer or counterparty ..." and Wu and Olson (2008) define it as "... risk of loss due to default on a debtor ...". All the mentioned definitions point to one fact, namely the necessity of appropriate selection and correct evaluation of the contractual partner, the client. Financial institutions are trying to address this issue by using a number of tools, e.g. credit scoring, ratings, or credit commissions for partner assessment and the like. The client is assessed from the point of view of the risk of collection of performance rather than solvency. In these established processes, leasing companies use all available information by default to compensate for information asymmetry and reduce the likelihood of adverse selection.

The economic phenomenon of unfavorable choice could be briefly described as the fact that an individual's demand for service grows in proportion to his exposure to risk. However, as its exact risk factor is unknown to the institution itself, it must resort to the above procedures and differentiate clients according to certain factors and criteria. The analysis of the provision of information and transactions at this level from the point of view of game theory has already been dealt with by several authors, e.g. Rasmusen (2006). In the classic principal-agent leasing game, the game begins by assigning characteristic features to each agent (client) that are known to him but not to the principal. There are usually higher and lower risk agents. The game continues by offering the principal an agent to conclude a contract and the opportunity to classify him according to the information obtained. The resulting contract with the individual agents reflects the relative level of expectations.

For example, for banks, their product portfolio is primarily based on keeping the savings of a large number of retail depositors, and in a stable market situation, it is unlikely that all clients will come to withdraw their deposits at the same time. At the same time, they have high revenues from various administrative and brokerage fees, and thus they can expand their activities to provide other products that already involve risk and, of course, return for the business. However, for leasing companies, it is necessary to integrate the insolvency risk management of clients with the management of other corporate risks.)

2 Methodology

This section is intended to present a technique that is often used in practice to analyze problems with a dichotomous dependent variable. Discriminant analysis (DA) as a whole deals with the relationships between a categorized and a set of variables related to it (McLachlan, 2004). This method is currently used quite often for research in the economic sphere, for example in the field of banking (Pasiouras and Tanna, 2010) or finance (Sueyoshi and Goto, 2009). The main task of DA is to predict the affiliation of

a dependent (group) variable to a certain group, type or category based on a set of independent (predictive) variables. In this respect, it recalls multiple regression, although it is most often used when there are several categorization groups of the dependent variable, its application is of course also possible in the dichotomous problem. The course of DA could be described as:

- 1) Verification of whether it is possible to explain group membership by independent variables,
- 2) Finding the independent variables with the highest explanatory value,
- 3) Selection of a suitable classification function.

Assignment to an appropriate group is performed by predictive discriminant analysis based on a set of observations that are known to individual groups. This set is called a test set. The result is then the so-called discriminant function, for example in linear form:

$$D = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n \quad (1)$$

in which x is a vector of prediction variables, b is a vector of discrimination coefficients and b_0 is a constant. The division itself takes place using a certain classification rule, the criteria of which may take the form of a minimum distance between two points Δ or a combination of predictive variables and the estimated probability of belonging to a particular category (Huberty and Olejnik, 2006). The classification rule follows one of these criteria and determines the required group affiliation. For example, Δ is used as an index of the distance between two points in p dimensional vector space. In this case, the basic requirement for comparing the distances of several variables is the same metric when calculating the individual distances. One way to achieve this is to take into account the different variances and the correlation of the variables. The most commonly used Mahalanobis distance (1936) is a measure of the distance between two points in space of correlated variables with different variances and is expressed as:

$$\Delta_{AB}^2 = (x_A - x_B)^T \Sigma^{-1} (x_A - x_B) \quad (2)$$

Discriminant analysis covers a wide range of classification rules and their criteria, and this brief mention for the purposes of our research is far from providing a sufficient overview.

3 Results

When modeling the payment default, a sample of 6,000 clients of an unnamed leasing company for 2020 was examined. 4,255 (70.9%) of the clients in the sample were standard and 1,745 (29.1%) were non-payers. The individual variables that were originally expected to affect the riskiness of the client were gender, marital status, number of children, region of residence, frequency of payment (monthly / yearly), amount and number of years of payment. Discriminant analysis was calculated in IBM SPSS Statistics.

The discriminant analysis was designed to solve problems with a limited dependent variable, and therefore it should cope with this categorization task. In the following tables we see the output of the performed DA in the statistical software SPSS. Table 1 shows the eigenvalue of the discriminant function. Eigenvalues describe the discriminant power of the respective eigenvectors. In DA, the maximum number of discriminant functions is the number of categories minus 1, which in our case represents a single function. Each of the functions has exactly one eigenvalue, which indicates the part of the explained variance, and for the purposes of our research it will represent the equivalent of the determination coefficient R^2 . A high eigenvalue represents a strong discriminant function. The canonical correlation represents the correlation between the achieved discriminant value and the values of the prediction variables. In the case of a single function, it provides an index of the overall quality of the model, and its high level again means good function.

Table 13. Eigenvalue.

Function	Eigenvalue	% of variability	Cumulative %	Canonical correlation
1	0,187	100	100	

We see that the size of the eigenvalue indicates approximately 5% better explanatory power of the model than in the previous methods, but 18.7% is still not a high value. When calculating the answer, we get an even lower figure in the form of 18.6%. The canonical correlation is already showing some improvement, as almost 40% is a commonly achieved indicator. The coefficients of the canonical discriminant function in Table 2 have a similar role as the coefficients in the common regression equation. The discriminant score of each subject is calculated by entering the magnitudes of its true independent variables into the discriminant equation.

Table 2. Coefficients of the canonical discriminant function.

Input	Coefficient
Const	-2,437
Sex	0,125
Age	-0,016
State	0,293
Children	0,293
Region	0,050
Payment	0,083
Amount	0,088
Period	0,151

In Figure 1, for better clarity, the distributions of the achieved discriminant score for both categories are presented, i. e. payers and non-payers. The more different the observed values and the histograms in other places, the better the discriminant analysis achieved the classification ability. We can see that the charts for the group of borrowers and regular clients almost overlap, which indicates poor results.

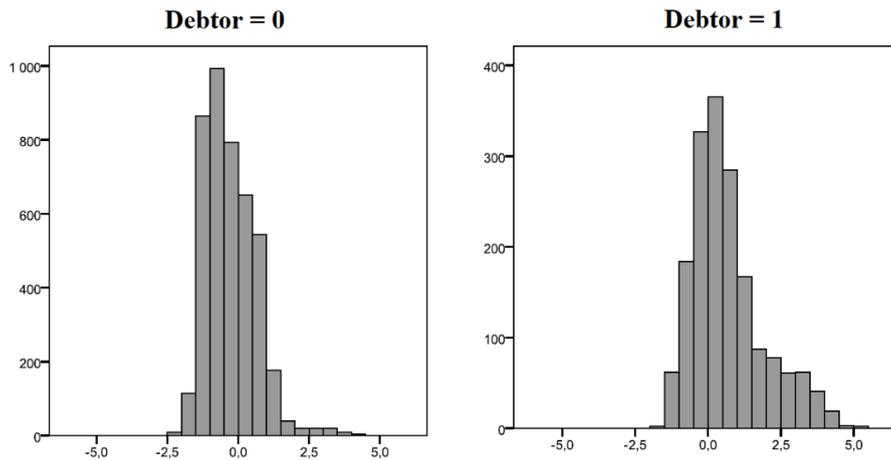


Fig. 14. Discrimination score

The last indicator, which, as in the case, we will involve in the evaluation of this model, is the number of correctly classified samples. 68% of the legal predictions in Table 3 represent a relatively applicable model. In the above context, it is necessary to note that, unlike in technical problems, socio-economic issues are often a result of a complex interaction of many parameters. Therefore, it is possible to consider the informative value of the model in the vicinity of 70% as acceptable and in business practice as relatively usable. To enhance the significance of the model, it is possible to focus on exploring other robust methods in the field of risk assessment to increase the accuracy of prediction and applicability in real business.

Table 3. Number of correctly classified examples.

Reality		Predicted	
		0	1
	0	3073	1182
	1	717	1028
Successful		68%	

4 Conclusion

Although a leasing company is, by its nature, exposed to the phenomenon of information asymmetry and adverse selection, by default, knowledge about the client's condition is the subject of its examination before concluding a new contract. The main goal of the presented work was to point out these large amounts and to predict the risk of payment failure of clients using discriminant analysis. The model was tested on a sample of 6,000 clients of an unnamed Slovak leasing company, which contained information on their gender, marital status, number of children, region of residence, frequency of payment and the amount and number of years of payment.

At present, discriminatory analysis is a frequently applied method in a wide range of corporate finance and management issues. Although it requires certain assumptions and conditions to be met, it can often provide better results than other conventional statistical and econometric models. In the interests of efficiency and better management, it would therefore be advantageous to integrate these mechanisms into the decision-making processes and insolvency risk management of leasing companies' clients.

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The Impact of Monetary Policy Instruments on the Euro Area Labor Market in the Context of COVID-19 Pandemic – Time-Varying Parameter VAR model approach

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Abstract. The paper examines simplified backward and forward transmission mechanism of monetary policy instrument to perturbation in un-employment rate. We apply three variables time-varying VAR model, with stochastic volatility, to determine the dynamic relationship among unemployment rate, interest rate and supply of money in the context of Euro Area. We concluded that, there is a possible stabilization potential through the increase in the money supply has dramatically risen before (and after) the COVID-19 pandemic; the reaction function of ECB to negative unemployment shock has been tied-up by the zero low bound and space for intense interest rate decrease has been empirically reduced in the pandemic times.

Keywords: monetary policy, pandemic, unemployment

JEL classification: C32, E37, E52

1 Introduction

The Euro Area labor market was severely hit by the SARS-COV2 pandemic and associated containment measures. Most academics would agree on the notion, that pandemic combines both supply and demand shock to European economy (for a short discussion see Baldwin (2021; 2020)). According to Brinca, Duarte, a Faria-e-Castro (2020) decomposition of hours worked in the US economy the labor market was severely hit by the supply shock due to mitigation measures, which consequently cause drop in the consumption rate due to job-losses. In Europe the total hours worked declined at the sharpest rates on the record. The labor force declined by about 5 million

in the first half of 2020. The decomposition of worked hours and labor force decline in the Euro Area labor market indicates the same similarities and differences from the financial crisis, as in the US context. During the financial crisis the demand shock accounted for two supply shock in labor force decline, current pandemic crisis indicate the direct opposite correlation (Anderton *et al.*, 2021). To minimize the short-term and long-term disturbances in the labor market and negative feedback loops to aggregate demand, the massive intervention of both labor market fiscal policies as well as massive monetary stimulus is needed. The pandemic however created a potential to long-term more productive re-allocation of labor, due to strong pressure of digitalization and automatization. These trends may have adverse effect on the deepening the skill mismatch, which could possibly lead to higher structural unemployment and further economic divergence among labor markets in Europe.

However, the European monetary policy is facing secular decline in the equilibrium real interest rate, which has limited the room for policy-rate reduction in the future recession (Coenen, Montes-Galdon and Schmidt, 2021). The unconventional monetary policy instruments were introduced, mainly captured by the rise of highly liquid money supply and a negative a policy-rate. Due to necessary transformation of monetary policy instruments, the relationship among them and unemployment may have changed.

In this paper we will examine to what extend the structural change among main monetary instruments and unemployment is observed in the data, and we will determine the rate (potential) of aggressiveness of ECB reaction to current pandemic crisis in terms of expansionary measures.

2 Materials and Methods

The bilateral effect of monetary policy instruments to unemployment rate in the level of Euro Area was estimated using three variables; seasonally adjusted unemployment rate, interest rate (EONIA-monthly average) and money aggregate M3; in the period of January 2010 to Jun 2021, on a monthly basis.

Based on the assumption, that the variables has unit root and are not cointegrated, we can estimate the time varying parameter VAR (TVP-VAR) model, which has a different structure from the standard VAR model, in the respect of changing estimated parameter over time (Primiceri, 2005). Nakajima (2011) extends Primiceri's approach with comprehensive and robust estimation algorithm including stochastic volatility for the TVP-VAR model. Stochastic volatility combined with TVP-VAR, allows us to capture possible structural changes of the economy.

The structural VAR representation of multivariate time series can be defined as follows (Primiceri, 2005; Nakajima, 2011):

$$A\mathbf{y}_t = F_1\mathbf{y}_{t-1} + \dots + F_s\mathbf{y}_{t-s} + u_t \quad (1)$$

Where \mathbf{y}_t is a $k \times 1$ vector of three endogenous variables (unemployment rate, short-term interest rate, money aggregate M3); A, F_1, \dots, F_s are a $k \times k$ matrices of coefficients.

The disturbance u_t is a $k \times I$ structural shock with $u_t \sim N(0, \Sigma)$ distribution, where $\Sigma_t = \text{diag}(\sigma_{1t}, \dots, \sigma_{3t})$.

The structural shock can be assumed by lower-triangular A matrix (Nakajima, 2011),

$$A = \begin{pmatrix} 1 & 0 & \cdots & 0 \\ a_{21} & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ a_{k1} & \cdots & a_{k,k-1} & 1 \end{pmatrix}$$

The VAR model in equation (1) can be rewritten in a reduced form:

$$y_t = B_1 y_{t-1} + \cdots + B_s y_{t-s} + A^{-1} \sum \varepsilon_t \quad \varepsilon_t \sim (0, I_k)$$

where $B_i = A^{-1} F_i$, for $i = 1, \dots, s$. Stacking the elements in the rows of B_i to the $k^2 s \times I$ vector β , and defining $X_t = I_s \otimes (y'_{t-1}, \dots, y'_{t-s})$, the model with all invariant parameters can be rewritten as:

$$y_t = X_t \beta + A^{-1} \sum \varepsilon_t \quad (2)$$

The model with time-varying parameters with stochastic volatility and time-varying parameters can be specified in the following form:

$$y_t = X_t \beta_t + A_t^{-1} \sum \varepsilon_t \quad (3)$$

with the time-varying coefficients vector β_t , created as stacked row vector of B_{1t}, \dots, B_{st} ; $a_t = (a_{1t}, \dots, a_{qt})'$ is stacked row vector of the lower-triangular elements of A_t ; $h_t = (h_{1t}, \dots, h_{qt})$, where $h_{it} = \log \sigma_{it}^2$. All time-varying parameters A_t and \sum_t follow the random walk process (Nakajima, 2011):

$$\begin{pmatrix} \beta_{t+1} \\ a_{t+1} \\ h_{t+1} \end{pmatrix} = \begin{pmatrix} \beta_t \\ a_t \\ h_t \end{pmatrix} + \begin{pmatrix} u_{\beta t} \\ u_{at} \\ u_{ht} \end{pmatrix} \sim N \left(0, \begin{pmatrix} I & 0 & 0 & 0 \\ 0 & \Sigma_\beta & 0 & 0 \\ 0 & 0 & \Sigma_a & 0 \\ 0 & 0 & 0 & \Sigma_h \end{pmatrix} \right) \quad (4)$$

for $t = s + 1, \dots, n$, with $e_t = A^{-1} \sum_t \varepsilon_t$, where Σ_a and Σ_h are diagonal matrices, $\beta_{s+1} \sim N(u_{\beta 0} \Sigma_{\beta 0})$, $a_{s+1} \sim N(u_{a 0} \Sigma_{a 0})$, and $h_{s+1} \sim N(u_{h 0} \Sigma_{h 0})$. The random walk specification allows to model sudden breaks in the evolution of the parameters and captures gradual changes in the relationship among variables.

The estimation procedure was based on functions and algorithm developed by Nakajima (2011). Suitability of our dataset was tested with Augmented Dickey-Fuller (for unit root tests) and Johansen test for cointegration. *Matlab* and *Stata* software was used for this purpose respectively. Noteworthy here is optimal lag selection, according to HQIC and SBIC the first-order lag can best fit our data.

3 Results

The unit root tests indicates that all our time series data are non-stationary at their level data but become stationary when first differencing them, suggesting that they are all integrated at order one at 5% significance level. Johansen test for cointegration indicates, that none of our time series is cointegrated. These results allow us to use TVP-VAR model to model data in their first difference form.

To begin with our estimation, we plot the time-series with their Nakajima's indicator of stochastic volatility in specific periods (see Figure 1). We observe rather static and slowly increasing trend of stochastic volatility in unemployment rate and M3 aggregate. In the case of interest rate, we observe some abrupt changes of their stochastic volatility due some unobserved major factor, in the periods of 2010 till the beginning of the 2015, and as the interest rate are below the zero low bound, the stochastic volatility decreased significantly.

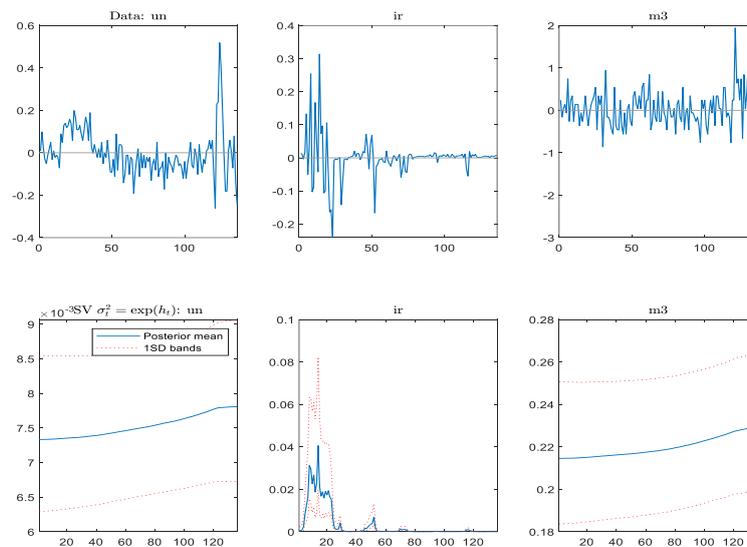


Figure 15. Time-series of unemployment rate, short-term interest rate (EONIA-monthly average), money aggregate M3 (all in first difference form). Stochastic volatility indicator for 2010-2021 periods.

Table 1 shows the estimates of TVP-VAR model with the MCMC algorithm with 15,000 iterations. It can be seen, that the Geweke statistics is greater than 10%, indicating that parameters converged to is posterior distribution. The ineffective factor

is less than 100 (except the parameters h), which meets the MCMC sampling with 15,000 sampling frequency. These results are supported by the autocorrelation functions (not displayed here). The estimates of mean value all parameters lie in the 95% confidence interval, which indicates effective and robust results of our estimation.

Table 14. Time-varying parameters VAR estimates

Parameter	Mean	Standard deviation	Confidence interval (95%)	Geweke statistics	Ineffective
$(\sum\beta)_1$	0.0023	0.0003	[0.0018; 0.0029]	0.177	7.13
$(\sum\beta)_2$	0.0023	0.000	[0.0018; 0.0028]	0.352	7.56
$(\sum a)_1$	0.0049	0.0012	[0.0033; 0.0078]	0.330	22.02
$(\sum h)_1$	0.0061	0.0032	[0.0034; 0.0134]	0.208	115.18
$(\sum h)_2$	1.0359	0.1856	[0.7039; 1.4345]	0.726	41.06

Next, we will analyze the impulse response function of constant version of our model. The impulse response function is a basic tool to see the macroeconomic dynamics captured by the estimated VAR system. For a standard VAR model whose parameters are all time-invariant, the impulse responses are drawn for each subset of two variables in a model.

We firstly estimate the constant VAR model, and the impulse responses are displayed on the Figure 2.

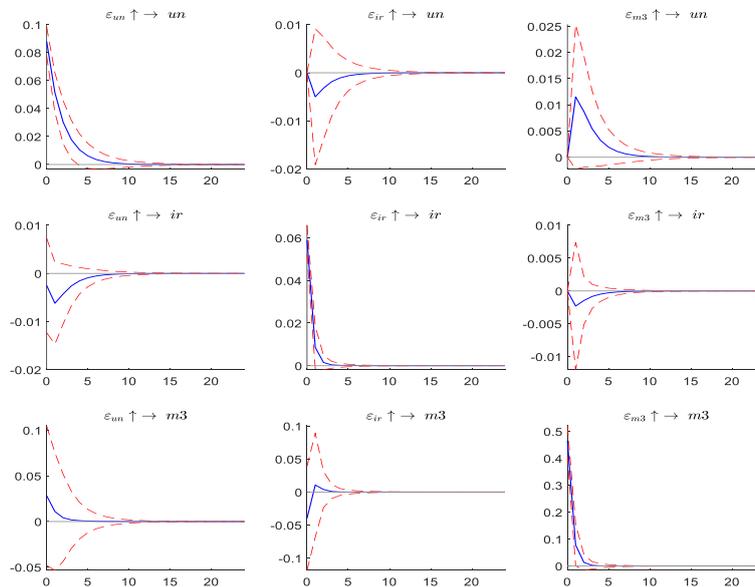


Figure 2 Impulse responses of constant VAR model, with 95% confidence intervals.

The constant VAR model indicates rather insignificant (inconclusive) relationship of negative shock in unemployment to both monetary instruments in the whole simulated period of two years. The effect of shock in unemployment is constantly zero after approximately one year lapsed. The opposite relationship of negative shock in interest rate indicates the expected slightly negative response of unemployment rate, but also not in a conclusive matter. The response on the money aggregate shock indicates expected negative relationship with the unemployment rate, but not significantly different from zero in simulated period. The reverse relationship indicates the same conclusions.

Since the key parameters of mutual relationship among unemployment and monetary instruments (may) have changed during the period of eleven years, we can discuss the impulse responses of time-varying parameters VAR model (see Figure 3). The responses of pairwise combinations are computed at all points in time using the estimated time-varying parameters (Nakajima, 2011).

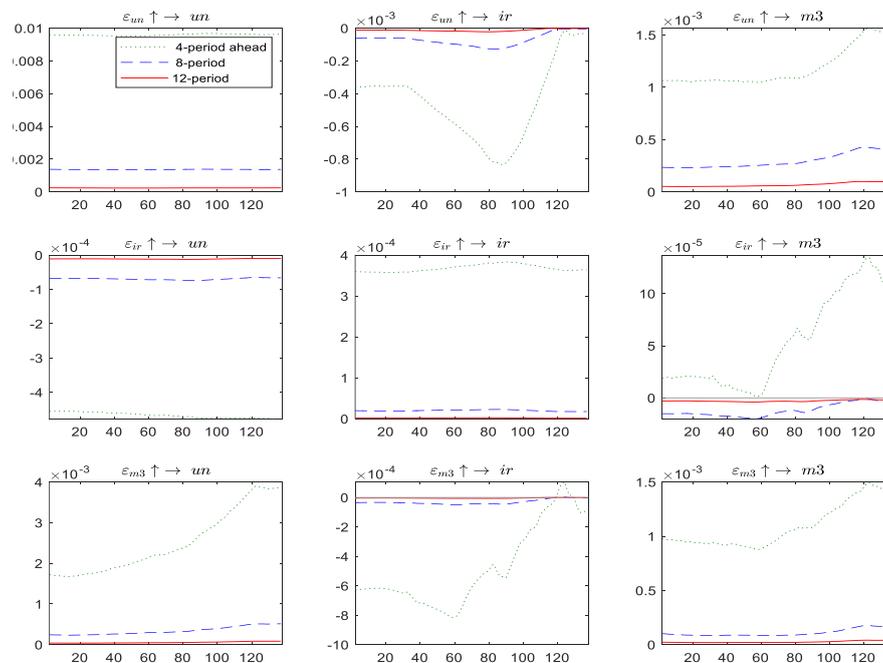


Figure 3 Impulse responses of TVP-VAR model (Feb 2010-May 2022) - posterior mean for one-quarter (green, dotted), two-quarters (blue, dashed), one-year (red, solid) ahead.

The impulse response function of negative shock in interest rate (due to expansionary measures) to unemployment ($\varepsilon_{ir} \uparrow \rightarrow un$) shows a similar behavior as described in the constant VAR model, and we do not observe some abrupt changes in mentioned direct transmission channel during the past decade, in estimated periods of four to twelve months.

Similar (but opposite, due nature of indicator) and expected behavior is observed between the 'tightening' of the money aggregate and unemployment ($\varepsilon_{m3} \uparrow \rightarrow un$). The TVP-VAR model indicates the changing sensitivity of unemployment to money aggregate tightening. It can be ascribed to the possible (and effective) change in the composition of money aggregate to more liquid assets, which can be more linked to the variation in unemployment rate. But its beyond the scope of our paper and we are referring to further research of mentioned hypothesis.

TVP-VAR model indicates that the opposite relationship; or backward transmission mechanism; of shock in unemployment to selected monetary instruments is gradually changing during the business cycle, especially on the short-term periods. The interest rate was mostly responsive to negative shock in unemployment shortly after the expansion in 2016 till 2018. After the European economy starts expanding, the monetary policy is becoming less sensitive to (simulated) rise in unemployment. In the period of observed dramatic turnover of interest rate response (July 2016) to unemployment, the policy-rate hits the zero low bound and in could be the symptoms of necessary, not a deliberate strategy. The simulated period after the pandemic hit suggests slightly more sensitive response of short-term interest rate to unemployment, however we must consider the persisting zero-low bound in all simulated periods. The one-quarter impulse response function, during the periods after the pandemic hit response function displays very mild decreasing sensitivity, with indication of slight (but correct) response of the monetary authority to current labor market worsening. The money aggregate to unemployment shock shows the counter-cyclical response in the all-projected periods. The simulated short-run posterior mean indicates the loosening monetary aggregate after the rise in unemployment, with a little decrease in a sensitivity after the pandemic hit. But the high effort of monetary authority in terms of expansionary reaction to unemployment perturbation are continuously and significantly seen in the data in recent months.

The TVP-VAR model impulse response functions can be drawn in an additional dimension - time, we have plotted the time-varying response functions on Figure 4 and 5. In the connection with the Figure 3 the time-varying nature of model could be fully appreciated.

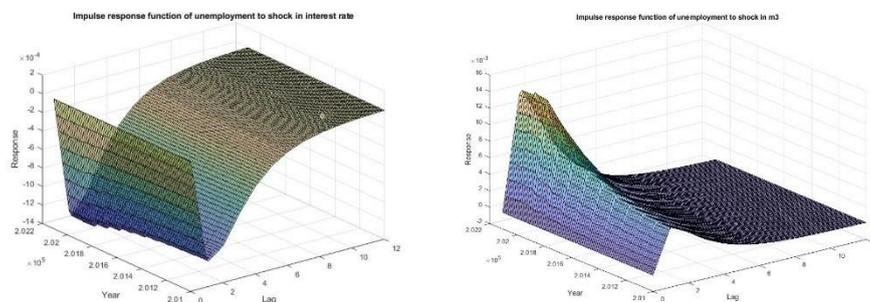


Figure 4 Three-dimensional impulse response function of negative monetary instruments shock to unemployment rate. The X-axis (Year) represents each point of time at the data period, the Y-axis (LAG) represent the time elapsed from the shock in respective monetary instrument. The Z-axis represents the response size in the unemployment rate.

As we have mentioned the data indicates that unemployment rate is becoming a little more responsive to positive shock in interest rate in the current crisis, the degree of sensitivity to the money aggregate tightening (loosing) is substantially higher. We are observing potential effective (and short) stabilization of unemployment rate due to following marginal rise of M3 aggregate.

Lastly, we simulate the impulse response of monetary instruments functions to the shock in unemployment rate. The response of money aggregate seems intuitive classical response function of central bank, and timely invariant in its nature.

The left upper and bottom boxes of Figure 5 simulate the impulse response function of short-term interest rate to shock in unemployment rate. We can easily identify the interest rate sensitivity to unemployment fluctuation in the past. With the very loosen and responsive policy rate, with its culmination in the 2018 when the interest rate hits the zero-lower bound. In the environment of low inflationary expectations, secularly decreasing equilibrium real interest rate and slow growth environment discourage the central bank from rising the policy rate above zero, despite the labor market overheating. Empirical data suggest that the central bank is constantly tightening its reaction function. The ECB starts to slightly tighten the policy rate sensitivity in the expansion and would have intention to more prudently reacts to shock in unemployment in the environment of labor market overheating.

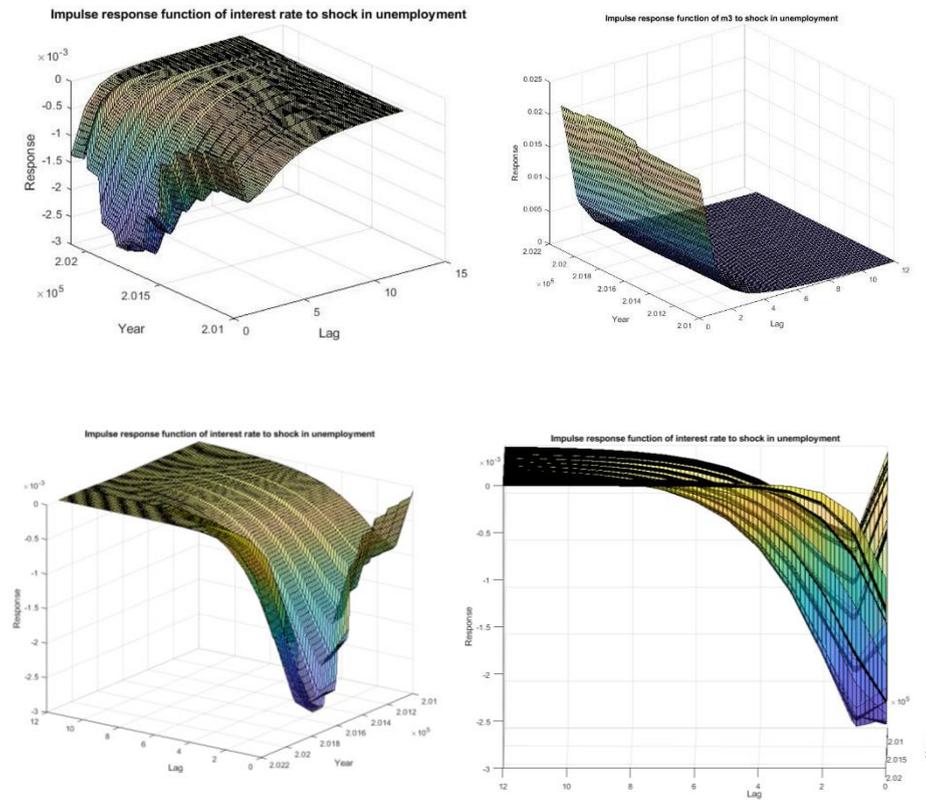


Figure 5 Three-dimensional impulse response function of positive unemployment shock to monetary policy instruments. The X-axis (Year) represents each point of time at the data period, the Y-axis (LAG) represent the time elapsed from the shock in unemployment. The Z-axis represent the response size in the respective instrument.

The current period simulated on the bottom box of Figure 5, indicates a slightly aggressive reaction of ECB policy-rate to shock in unemployment comparing to recession in 2013. Despite she is tied-up by the zero low bound. The last shock to unemployment is simulated in the May of 2021, the model indicates the possible sharp decline of interest rate after five months, policy rate change will return to zero in the July of 2022.

Despite the very limited monetary instrument intervention, the behavior of interest rate indicates the loosen frame of current monetary policy making, which could be effective in such enormous labor market shock in relation to rising backward link among policy-rate and unemployment (left graph Figure 4). It must be added that the persistence of loosen monetary policy (and possible chances to stabilization) has dramatically shorten since the 2018, which is the major secular trend the monetary authority face in the context of current pandemic identified in our paper.

4 Conclusions

Central banks' *Gordian knot* of effective stabilization in the low equilibrium real interest rate, empirically does not render monetary stabilization *per se* ineffective (Coenen, Montes-Galdon and Schmidt, 2021). In our paper we have examined the simplified relationship among interest rate, monetary aggregate, and unemployment rate. Applying the time-varying VAR model we are concluding the relationship among these variables has changed, during the last decade but not completely paralyzed the ECB from some *quasi-causal* control of unemployment rate. Last asset purchased on the financial market somehow changed the sensitivity of unemployment to changes in money supply. Even though the transmission mechanism of interest rate to unemployment indicates a time-invariant relationship, the backward relationship of unemployment to interest rate shows the shortening influence of interest rate on the real economy.

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Goal Setting and KPI Measurement as Tools for Broader use of Online Gamification

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Abstract. Gamification is used in various HR areas since the 90s. With technologically savvy generations coming to workplace gamification importance as learning, motivation and communication tools shall be growing. However, its spread across industries and its intensity of use is limited so far. The lack of measurement, publication and comparison of gamification outcomes and effectiveness in reaching its goals may be burden for management in gamification implementation. In the article, we describe situation, when gamification is used to present new employers value proposition (EVP) to potential candidates as a HR tool. Using goals and KPIs in measuring impact of the gamification helps to evaluate impact of the tool and may help HR to justify its use in front of the company management in future as well. To conduct the research, we chose management best practice in goals setting and KPI measurement. Further, on case study “Online EVP gamification of New Generation Hospital” we prove that using gamification goals and KPIs gives management answers regarding its effectiveness. The conclusions expand the knowledge about measuring the effectiveness of online gamification.

Keywords: Gamification, goal setting, KPI.

JEL classification: M12, M14, M54

1 Introduction

Gamification has been defined as a HRM tool to increase engagement and motivation to learn, as well as the quality and quantity of what is learned since the 90s [1].

According to Gupta and Gomathi [2], the need to use gamification can be attributed to a change in the composition of the workforce, which is now dominated by echo

boomers/Gen Y, which grew under the influence of technology, e-commerce and to large extent dependent on it. However, despite the growing number of employees of the technologically savvy Generations Y and Z, this tool has not been significantly expanded. Studies speak of dozens, not thousands of gamified devices.

Sridevi and Jain noticed similar fact - the application of gamification has met with limited success in the organizations. According to them, researchers have attributed this failure to incomplete understanding of the concept [1]. Similarly, Gupta and Gomathi point out on the need to expand and build a strong theoretical basis for the concept of gamification in order to realize its full potential in academia and industry [2].

Moreover, the preparation of gamification, especially online gamification, is time-consuming and costly, as it comprises work of creatives, content writers, designers, programmers and substantial time of subject matter experts, usually internal HR or business team.

We believe, that the lack of measurement, publication and comparison of gamification results and effectiveness in achieving its goals hinders its wider dissemination. We expect that expanded knowledge on the data, KPIs and goals, that gamification fulfil will increase the interest of company boards in the implementation of this tool.

The aim of the article is to expand the knowledge about measuring the effectiveness of online gamification and to generalize the possible goals and KPIs of online gamification for wider use in other online gamifications and thus demonstrate its benefits and promote its use.

The contribution of this work is in analyses of the gamification data on a concrete example and on determining the degree of its effectiveness through meeting the gamification goals and KPIs. Doing so, we contribute to expedition and building of a strong theoretical base for the gamification concept.

2 Literature Review

Gamification is defined by many authors as real world activities, situations, which have game-based characters, design, aspects, principles, points, badges, leaderboards and so. Gamification can be understood as method of driving internal and external customers' engagement and motivation to influence business results [3].

Gamification can be performed online, through digital platform or in real world game-based interface. It can be used in each industry by all the different departments of the company: HR, financial, strategic, marketing, sales, purchasing etc. [4,5].

Gamification can have one or few following goals, that can be achieved: to make boring tasks more fun, increase employee's motivation, engagement, loyalty, promote positive organizational culture, create a friendly atmosphere in teams, etc.

Gamification can be used by HRM as a powerful tool for: recruiting and retaining employees, identifying their strength and weaknesses, designing and providing proper training for them, identifying employees with the highest level of performance, motivating, engaging and promoting, creating or modifying their career plans, identifying and predicting employees, who may leave the company, create the desirable

EVP (Employ Value Proposition) for them, promoting company as a brand through personnel marketing and employer branding, etc. [6,7,8].

2.1 Gamification in EVP/employer branding

EVP (Employer Value Proposition) and employer branding are methods used by HRM, that focus on existing and potential employees and try to deliver unique values based on compensation, benefits, career opportunities, work environment and corporate culture. With help of these methods HRM can:

in case of existing employees – increase employee engagement, satisfaction, referral rates and employee loyalty rate, decrease turnover rate, build trust between existing employees, prevent talented candidates from leaving and etc. [14].

In case of potential candidates – get more job applicants, build trust between potential candidates, attract talented candidates, increase offer-acceptance rate, brand awareness, perception as well as candidate engagement rate and etc.

As we can see both methods are phenomena, that complement each other. Even though the concepts have certain differences, they are closely related since both speak of an organization as a favorable place of employment. An employer's brand can be seen as a set of compelling reasons or promises why a brand is a „great place to work“, while EVP is a set of concrete steps, that company has taken to make the promises a reality. With help of these methods, HRM can use existing employees as a powerful tool to influence, persuade, attract potential employees and visa versus.

By implementing and using gamification in designing EVP and employer branding, HRM can effectively design and define:

Employees' training, education and development programs – through gamification, HRM have the opportunity to identify the strengths and weaknesses of employees and later provide education, training programs tailored to the needs of employees, which can be considered a strong element of EVP. Helping them to transform their weaknesses into strength can make them happy, as well as satisfied and happy employees can be considered as „word of mouth“ and a tool of employer branding by spreading positive information outside of company and raising awareness of potential employees [13].

Compensation and benefits – with help of gamification HRM can define an effective, sufficient package of compensation and benefits for employees by designing games, that allows them to identify and adapt individual or group preferences and the needs of employees to material or non-material elements. Tailoring and adjusting elements of compensation and benefits can be used as a powerful tool of EVP to motivate, engage existing employees, prevent them from leaving and attracting potential talented candidates [14, 15].

Employee career plans – gamification gives HRM opportunity to identify employees' career interests. With help of game, they can see which job position employees play, what results they have and where they need to develop. Managers can use collected data to design employees' career plans, based on the interests, skills, knowledge and abilities of specific employees. Tailored career plans can motivate and engage employees and attract potential candidates. [16,17].

2.2 Goals setting and Key performance Indicators

The key performance indicators (KPIs) represent indicators, that allow companies, different departments (in our case HRM) to: measure and quantify whether their current performance is with accordance of their desired targets, goals, objectives, increase the level of performance and compare their results to their competitors' performance [18]. As an indicator can be considered only those, which have a direct link with the company's or departments' goals, targets and can be measured, quantified.

A KPI can only be effective and accurate if it: has as few indicators as possible, focuses on the essential indicators with direct link to goals and leaves the rest out, focuses on particular activity, goal and target, is as simple as possible (otherwise, it would be hard to communicate and focus on). Different goals and targets should be measured and evaluated by different KPIs [20].

KPIs can have financial and non-financial characters. In terms of gamification, HRM can consider as good indicators: ROI from EVP, employer branding, training and so, sales growth rate, absence rate, benefits related satisfaction calculated based on survey, employee productivity rate, employee engagement or innovative index, internal promotion rate, Net Promoter Score, turnover rate and so on [19].

3 Methods

We searched contemporary literature sources to review studies in application of gamification principles in HRM. We used induction and deduction methods to identify the extent of current knowledge about the use of gamification to create and communicate EVP as the core of the employer branding. Applying synthesis on the current knowledge we have identified and defined the gap in the research of gamification in HRM. We have identified the lack of knowledge about efficiency measurement of gamification and its impact upon reaching the company goals. Subsequently, we have formed the research design for the purposes of this study.

Main research goal: Introduce the methodology of measuring impact of online gamification on Employer branding concept to support its broader implementation within HRM.

Research question: What are the gamification KPIs measuring impact on the company goals in Employer branding concept?

The subject of our research was online gamification as the tool for communication EVP - the core of Employer branding. We have examined the subject in New Generation Hospital Bratislava-Bory, since the organization has recently introduced the HRM strategy and is currently focused on forming its human potential. NGH will employ 1400 employees, with the aim to cover 320 positions of doctors, 400 positions of nurses, 500 other medical positions and 180 operational staff.

For measuring the impact of online gamification on Employer branding in this study, we have analyzed KPIs for online EVP gamification goals in NGH. For gathering data of responsiveness, we have used Google Analytics methodology in the period of eight months, November 2020-June 2021.

4 Results

Based on an examination of the findings of published studies, we find added value of gamification in HR processes, employer branding and EVP in particular.

The subject of the research published in this article are examples of gamification KPIs and their implementation in online EVP gamification of the New Generation Hospital Bratislava-Bory.

4.1 Gamification KPI

In business, gamification is used as a tool to achieve specific organizational goals. Goals are measured by using key performance indicators (KPIs). In order to measure the KPIs, it is necessary to collect data from gamification.

Although online gamification is tailored to the organization and shares common design principles. The design principles such as badges, buttons, decision points, etc., makes it possible to collect data on use of the online gamification.

In general, the online gamification collects data about the attractiveness of the gamification topic and player preferences he expresses during the game. The attractiveness of the gamification topic is expressed by data as number of overall and unique accesses to the game page (and calculated % of re-entries), number of overall and unique games starts, number of overall and unique games exits (and calculated % of game exits) and number of left contacts. Player preferences are expressed by number of various choice buttons presses such particular game selection, character selection and number and type of badges earned.

Gamification data can be further used to calculate gamification KPIs. Financial KPIs, that depict return on investment into the gamification are for example cost per one view of the gamification landing page (costs/number of people reached), cost per 1 engaged player (i.e., cost per gamification entry), cost per 1 contact (cost/interest gained directly from the gamification – e.g., in form of CV, or contact address). Non-financial KPIs demonstrate other type of data gained through gamification. In case of multiple game choices this could be area of interest to players (most played game and most completed game, character selection). In case of badges earned by players collection of data about characteristics of the players.

4.2 Case study – Employer Value Proposition Gamification of the New Generation Hospital Bratislava - Bory

EVP of the New Generation Hospital Bratislava-Bory. A New Generation Hospital (NGH) that will bring jobs for 1,400 new employees is being built in the capital of Slovakia, in Bratislava- Bory. The hospital will not only be innovative in technology and medical processes, but also has the ambition to bring organizational culture change to of healthcare. The main attributes of the hospital were the basis for the creation of its employer value proposition (EVP). The EVP was created for three main categories of employees - doctors, nurses and operations staff. As the new hospital is only in construction, the EVP of the future hospital is presented to the candidates through

various offline and online communication channels. The main online communication tool is the company's website, where information, links to podcasts, photo and video galleries, a real time camera from the hospital building, etc. are concentrated.

In February 2020 due to the spread of the COVID pandemic, personal contacts were restricted and thus substantial part of offline communication channels, such as personal meetings, workshops etc., were cancelled. Hospital management defined need for a new tool that will present the new employer and its EVP and generate interest in potential candidates to work in the new hospital. The decision was to implement online EVP gamification. The decision was made on 2 premises. Firstly, pandemics restricted personal contacts and management was looking for online tool. Secondly, online was already heavily used by hospital and management was looking for innovative tool. Gamification was recognized as tool fitting both premises, however without robust background on its effectiveness. As the production of the tool is costly, the implementation of the tools was approved under condition of measuring it impact.

Gamification goals and KPIs. To measure impact of the gamification tool, management defined 4 goals and assigned to each key performance indicators (KPIs), that measure it. The goals support company's talent management strategy and have were set in accordance with SMART method.

Table 15. NGH Online EVP gamification goals and KPIs.

GOAL	KPI
1. INTRODUCTION OF THE EVP All players will receive information about the key attributes of an EVP - a digital hospital with a strong patient focus and a motivating working atmosphere.	<ul style="list-style-type: none"> - Each games contains at least 3: <ul style="list-style-type: none"> o Innovations o Badges for patient care o Badges for soft skills - Min. 75% overall completion of the game.
2. GAIN PUBLIC INTEREST Increase traffic to hospitals website which is both the hospitals primary place to advertise job openings and a central location for employer information by at least 10% in the period under review.	<p>Main KPI:</p> <ul style="list-style-type: none"> - 10% increase of traffic to www.nemocnica-bory.sk measured by Google analytics <p>Supportive KPI:</p> <ul style="list-style-type: none"> - Monthly game page entry at least 600 - Monthly unique game launch at least 300
3. RECRUITING CANDIDATES Getting new job seekers who are attracted by hospitals EVP presented in the gamification	<ul style="list-style-type: none"> - At least 30 new CVs per month exclusively from gamification (pressing button directly from the game, not from career subpage)

4. FINANCIAL EFFICIENCY Financially efficient tool compared to alternative tools such as advertising, job fairs, etc.	- Cost of 1 delivered EVP information measured by game completion is less than 4 EUR
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Source: Datastudio, 2021

Description of the online gamification. The online gamification is situated on the organizations' web page. The landing page invites potential candidates to try working in the new hospital via the game. The basis of the online gamification is the hospital's EVP, whose attributes have been embedded in 8 stories of two types of characters - doctor and nurse. In the gamification, the stakeholder meets different patients and colleagues and solves daily tasks and challenges. It's up to him how he handles them and what kind of behavior he displays during the tasks (teamwork, respect, responsibility, patience, stamina, etc.). In doing so, the character's decisions affect the mood of all the characters in the game and the overall plot. During the simulation, the player has the opportunity to get to know and discover several innovative procedures, and technologies of the new hospital. At the same time, it shows him his own qualities that he may not even know he has, but are observed and measured during the simulation by gaining badges (badge represents EVP culture aspects). At the end of the game, the gamification shows the summary of discovered innovations and whether the culture and working style of the new hospital would suit the player. The gamification ends with a "call to action" - an incentive to leave email contact or send CV.

Gamification data. The online EVP gamification was prepared with help of external provider within 5 months and launched in October 2020. Data presented in the table below were collected in the period of 8 months (November 2020-June 2021) via Google Analytics.

Table 16. NGH Online EVP gamification data November 2020-June 2021

	TOTAL	AVERAGE 11/20-6/21
GENERAL INDICATORS		
Game page access Total	6516	815
Game page access unique	6315	789
Repeat entries %	-	3,1%
Game starts Total	4226	528
Games starts unique	4086	511
Game exit Total	3735	467
Game completion %	-	87%
Left messages Total	383	48
Left messages as % of all games	-	7%
CHARACTER SELECTION		
Doctor	3272	409

Nurse	2363	295
GAME SELECTION		
Hospitalists	253	32
Emergency	1575	197
Surgeon	348	44
Ambulance	457	57
Medication	661	83
In patient nursing care	450	56
Delivery	416	52
New patient	404	51
BADGES SELECTION		
Sense and sensibility	1942	243
Heart on the palm	1543	193
Embodied willingness;	1561	195
Reading between the lines	1034	129
Breathing for team	1169	146
A helping hand	1205	151
Flexible	718	90
Member of family	379	47
Nerves of steel	378	47
X-ray view	278	35
Expert view	311	39

Source: Datastudio, 2021

Gamification Results. Overall, the online gamification of the new generation hospital EVP met all set goals (measured by KPIs) within the monitored time frame.

First goal, introduction of the EVP via the gamification was fully met. Each game contains at least 3 EVP elements of digitality, patient care and a motivating working atmosphere. The second KPI, overall game completion, which shows interest of the player in the content, was in average 87% and thus the goal was met as well.

Second goal, to gain public interest, was met. The main KPI measuring traffic to hospitals web site increased by 10.5%. From 1.11.2020 to 30.6.2021 overall 6 315 unique players opened the gamification page where new hospital introduces its EVP (175% KPI fulfilment) and the entire story has been played and completed 3 735 times (207% KPI fulfilment).

Third goal, recruiting new candidates, measured by unique contacts or CVs sourced exclusively through gamification button was met. During 8 months the hospital gained 383 unique contacts or CV via gamification, which was in average 48 per month (against KPI plan 30). However, gaining contacts or CVs purely after completing the game was not the key goal, only marketing best practice to finish the game with call for action. The key goal of the gamification was to gain interest in the EVP, get players (equals potential candidates) visit the hospital web page and search there for more employment related information.

Last goal, financial efficiency of the tool was measured by game completion, which equals delivered EVP information. In the period of 8 months the cost was 3,68 EUR (against KPI target maximum of 4 EUR). Moreover, as gamification is an online tool the financial effectiveness of online EVP gamification is automatically increasing in time with every new player.

5 Discussion

By literature review, we have found many authors explaining the types of use of gamification in HRM concepts. Most of the studies were researching gamification in recruitment concepts, which covers the impact on candidates. There were some studies focuses on gamification influencing retention, and engagement which is impact on employees. The principles of gamification in HRM have mainly been researched private sector companies. These have built valuable knowledge for understanding the contemporary tendencies in Employer branding concept as well as development of EVP being the core of managing attractiveness of an employer. Applying synthesis on the current knowledge we have identified and defined the gap in the research of gamification in HRM. We have identified the lack of knowledge about efficiency measurement of gamification used in HRM processes and its impact upon reaching the company goals. We have also moved the research into the healthcare service, since we have identified lack of research addressing specifics of management in healthcare service and increasing urgency for attractiveness of work in public healthcare service. Main research goal of this study was to introduce the methodology of measuring impact of online gamification on Employer branding concept to support its broader implementation within HRM.

The object of our research was the hospital of new generation, which is in the time of our research in its mature phase of establishment. The hospital is in heavy recruitment process, and being attractive for highly skilled specialists is one of the key pillars of its strategies. This might be considered one of the limitations of generalization of the study results. On the other hand, we find the object of the study relevant choice to research the HRM system in times of development of its competitiveness. The hospital HR leadership has decided to implement latest knowledge of HRM research and practice, and used gamification to form EVP and build attractiveness of Employer brand. For each online EVP gamification goals there was set of KPIs measuring the impact. Context to the indicators is given in chapter Description of the game. For gathering data of responsiveness, we have used Google Analytics methodology in the period of eight months, November 2020-June 2021. The results of measurement has shown that all set gamification goals measured through KPIs have been delivered. As additional result, 22 months prior to hospital opening and without running the main job advertisement campaign hospital have gained 130% of applicants for positions in the hospital.

Moreover, gamification has become a unique communication platform during the COVID pandemic, in which there are limited opportunities for employers to present.

Based on positive results of it, the hospitals management approved further investment in board game version for new employees' adaptation.

The research question of this study was to examine the impact of using gamification principals on the company goals in Employer branding concept. We have proven, there is significant impact of the gamification, which is measurable by KPI's quantified by analytical methodology. We have concluded, that gamification is helping in building attractiveness of employment in health care service, boosted by shift to digital environment as the new environment for future labor market.

Our research has several barriers and limitations to the application of its results. The study has been done in the emerging hospital of new generation, therefore we cannot generalize the findings for any kind of hospital or for private business or organizations in different forms or industrial sectors. We have also not proven the impact of gamification on attractiveness targeting retention of employees. The respondents in this study were in status of potential candidates. The potential of gamification tools for gaining more precise data from the players has not been fully covered by this research.

It is a challenge for the future research to all relevant data obtainable by both parties, employer and the candidate, with the intention to precise the people-organization fit. Google analytics in DataStudio does not provide data on demographics of players. Data as education, or age would help to analyze the results more precisely. Being this an innovation there is still potential for improving the tool

6 Conclusion

The main goal of the paper was to introduce the methodology of measuring impact of online gamification on Employer branding concept to support its broader implementation within HRM. As the result of our research we provide an example of the online gamification of the new generation hospital Bratislava-Bory EVP proved, that the setting SMART gamification goals measured by KPIs is feasible. In the study it proved the use of the gamification concept is feasible in the conditions of health-care service. In the paper, we have answered the research questions by following findings.

Firstly, if HR tools are backed up by SMART objectives measuring its effectiveness through KPIs, it is possible to measure their effectivity. It is especially important for tools dealing with soft HR topics that are abstract to many managers – e.g., theme of employer value proposition. The use of relevant data to support decisions is key in any business.

Secondly, online gamification provides data that can be analyzed and evaluated in KPIs.

Thirdly, the exact goals and KPIs depend on the type and purpose of the gamification. In general, they can include player engagement, level of the topic introduction, number of achieved tina contact or response, and financial efficiency.

The conclusions expand the knowledge about measuring the effectiveness of online gamification and in results part of this article we generalize the possible goals and KPIs of online gamification for wider use in other online gamifications. As goals setting and KPI measurement are key management tools for decision making and effectivity

measurements, we believe their application and use in when deciding about gamification use by companies may be valuable.

Further research of the topic may follow in the area of offline gamification. We believe, the above principles could be used also for offline gamifications. However, the data collection might be more problematic, than in the online environment.

Acknowledgement

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Game page access unique	1047	605	700	722	1124	739	381	997	6315	789
Repeat entries %	2,7%	3,3%	2,1%	4,0%	3,4%	3,9%	2,6%	2,6%	-	3,1%
Game starts TTL	538	584	630	558	813	514	310	279	4226	528
Games starts unique	520	565	618	528	796	496	302	261	4086	511
Game exit TTL	435	577	533	537	593	435	252	373	3735	467
Game completion %	81%	99%	85%	96%	73%	85%	81%	94%	-	87%
Left messages TTL	44	56	48	63	57	52	25	38	383	48
Left messages as % of all games	8,2%	9,6%	6,7%	8,4%	4,9%	6,8%	6,4%	3,7%	-	7%

Source: Datastudio, 2021

Table 18. Characters Selection by Months

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	TTL	AVG
Doctor	438	422	481	407	622	410	215	277	3272	409
Nurse	257	354	304	310	460	286	165	227	2363	295

Source: Datastudio, 2021

Table 19. Games Selection by Months

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	TTL	AVG
Hospita- lists	32	27	38	20	49	45	20	22	253	32
Emerg- ency	208	225	271	118	330	173	118	132	1575	197
Surgeon	54	50	46	24	63	55	24	32	348	44
Ambulan ce	74	75	75	24	83	53	24	49	457	57

Medication	82	109	92	46	128	92	46	66	661	83
In patient nursing care	64	77	54	36	94	49	36	40	450	56
Delivery	48	63	58	34	80	60	34	39	416	52
New patient	30	68	63	34	80	49	34	46	404	51

Source: Datastudio, 2021

Application of multivariate lambda distribution within the portfolio selection model

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Abstract. The article deals with the application of the resampling procedure using multivariate lambda distribution within the process of optimization of portfolio selection models. The aim of the resampling procedure is to achieve portfolios that provide better quality results on out-of-sample data compared to the traditional optimization-based approach using estimates from historical data. In this paper, we deal with the application of the resampling procedure on daily data of 30 assets within the model of portfolio selection in the space of expected return and CVaR (Conditional Value at Risk). We are dealing with the application of two approaches, an approach based on the assumption of normal distribution of data using multivariate normal distribution for data generation and a procedure using data generation from multivariate generalized lambda distribution.

Keywords: CVaR optimization, multivariate distribution, resampling.

JEL classification: G11, G17

1 Introduction

In the past, the application of the resampling procedure was dealt with by several authors, most of whom dealt with the application within the Markowitz model using monthly or weekly data [2], [5]. Only a small number of contributions dealt with the application on other models of portfolio selection or on applications in the case of using daily data. The aim of this paper is to apply the resampling procedure within the model of portfolio selection in the space of expected return and CVaR using daily data. The paper also deals with the application of two modifications of this procedure, namely the procedure using multivariate normal distribution and the procedure using multivariate generalized lambda distribution (GLD). The GLD distribution was selected based on previous research [8]. In the paper we use the modification of the CVaR model to the task of linear programming, originally presented in [10]. Within the computational

experiments we use FKML parameterization of the GLD distribution, a detailed overview of the issues concerning the GLD distribution as well as the formulation of the quantile function can be found, for example, in [1].

2 Resampling procedure

The procedure is generally based on the use of multivariate distribution on data generation and the Monte Carlo method, with a selected portfolio selection optimization model applied to each data simulation. The result of these procedure is a set of efficient frontiers quantified from individual random realizations of data, while the resulting frontier is obtained by averaging the weights of individual statistically equivalent portfolios.

Generating data from a multivariate normal distribution is a fairly well-known procedure that is currently programmed in most statistical software. In our paper, we use the `rmvnorm()` function contained in the `Mvtnorm` package in R [3]. In the case of generating data from a multivariate generalized lambda distribution, it is a bit more complicated. In the paper, we use the procedure of generating data from a multivariate non-normal distribution given in [4]. The application of this procedure requires that the distributions of the individual components of the random variable X must be known in the form of quantile functions and the correlation is available as a correlation matrix R_X using rank-based correlation (e.g. Spearman's correlation coefficient). Subsequently, the procedure consists of the following steps [4]:

1. Transform matrix R_x to matrix C_z applying statement:

$$C_z = 2 \sin \left[\frac{\pi}{6} R_x \right]$$

2. Generate data samples of m – dimensional normal distribution with correlation matrix C_z
3. Transform normal components into the components of uniform distribution by applying the distribution function (CDF) of the normalized normal distribution $U_i = \Phi(Z_i)$ such that $U_i \sim U(0,1)$
4. Quantify values of X_i using a given quantile function of individual components, $X_i = Q_{X_i}(U_i)$

The advantage of such procedure is considerable flexibility in the choice of the assumed distribution to the point that the quantile function must be known for the selected distribution.

Procedure of resampling within portfolio selection models was introduced by [7] and used in contributions like [9], [12]. We can classify it into the category of heuristics to solve the problem of portfolio selection [11]. Such a procedure reduces the problem of error maximization, for a more detailed description of this problem we recommend the paper [6]. The resulting portfolios of this procedure are more diversified compared to the traditional approach. The resampling procedure consists of the following steps:

- Estimate the parameters of the assumed probability distribution from historical data and estimate the covariance matrix.
- Then generate a vector of random realizations from a multivariate marginal probability distribution, using an estimated covariance matrix. The length of the generated interval is traditionally the same as the number of observations of historical data that we used in the previous step.
- The generated sample of data will then be used as input data for the portfolio selection model for estimating the efficient frontier. Save the values of weights for M evenly distributed portfolios at the efficient frontier by rank (from portfolio with minimal risk to portfolio with maximal return).
- Repeat the previous 2 steps many times, then average the weights of portfolios that share the same rank within the individual simulations.

3 Experiment results

Calculation of experiment are perform using daily data of closing positions of 30 assets, from 01.01.2012 to 31.12.2020. The assets consisted of DJIA components. We quantified daily returns as so-called logarithmic returns, i.e. the first difference of the natural logarithm of individual observations for individual assets. We use series of daily returns to estimating the parameters of the normal distribution and the parameters of the generalized lambda distribution, which we will use subsequently in the resampling procedure.

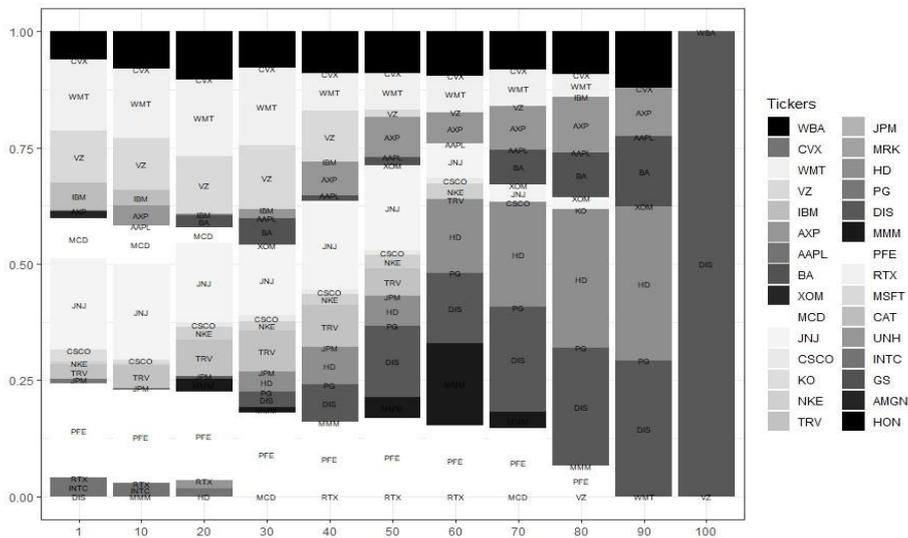


Fig. 16. Distribution of weights within selected portfolios at the efficient frontier quantified using the CVaR model and using of a "classical" approach.

To estimate the parameters of the distribution, we used the maximum likelihood estimation method, where when estimating the parameters, we consider a data sample for a period of two years, from 01.01.2012 to 31.12.2013. In Monte Carlo simulations, we performed 500 simulations, and in portfolio optimization using a CVaR risk model, we generated 100 evenly distributed portfolios at the efficient frontier.

In a computational experiment, we compare portfolios quantified using a "classical" approach using estimates from historical data compared to two resampling procedures, where in one case we are generating data from a multivariate normal distribution (Norm_mult) and in the other case we are generating data from a multivariate generalized lambda distribution (Gld_mult). We compare the performance of portfolios on a out-of-sample data, so without the data which we used to estimate the parameters of individual models. Specifically, it is a data sample from 01.01.2014 to 31.12.2020. As part of the experiment, we consider the scenario of an investor who invests in individual assets in accordance with selected constructed portfolios. There are three investment scenarios, a one-year investment horizon, a three-year investment horizon and a six-year investment horizon. An investor cannot sell the assets in which he has invested for the duration of the investment horizon. Investor can sell the assets only during the year following the investment horizon, but for a maximum period of one year. Specifically, in years 2015, 2017, 2020. In the experiment, we abstract from stock exchange fees and additional costs associated with the sale and purchase of assets.

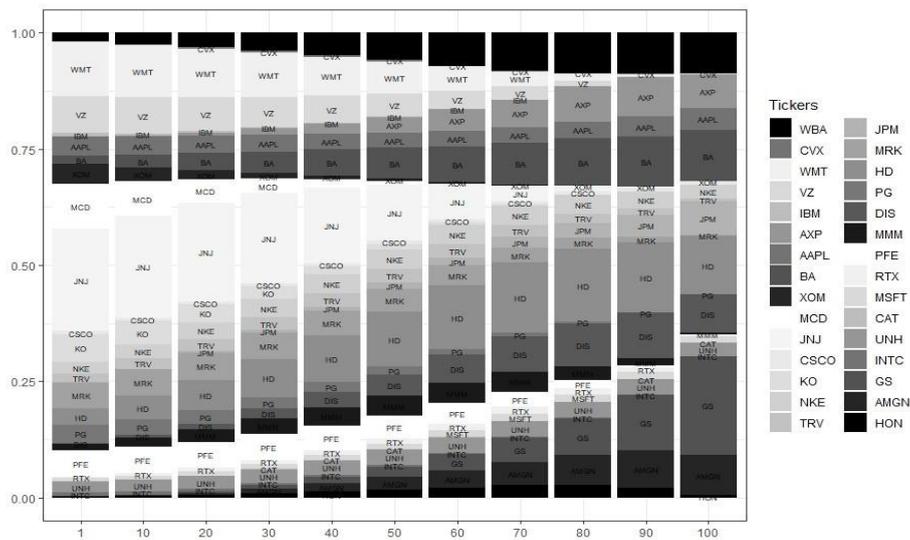


Fig. 2. Distribution of weights within selected portfolios at the efficient frontier quantified using the CVaR model and resampling procedure using GLD distribution as a model of daily returns.

We consider four representative portfolios from each model; for comparison, we have selected four portfolios from each model that share the same expected return to investors. To compare the performance of individual representative portfolios, we

quantify average statistics for a period of one year after the investment horizon, namely average return, mean absolute deviation (MAD) and the modified Sharpe ratio from performance measures, where we consider the mean absolute deviation as a measure of risk. Such a statistic is also referred to as the mean absolute deviation ratio. We chose the absolute deviation as a measure of risk (even in the case of the performance measure), as in comparison with the more traditionally used standard deviation and the Sharpe ratio, we are not limited by the assumption of a normal distribution of returns.

Figure 1 and Figure 2 are composite bar graphs where one bar is composed of smaller parts (different shades of gray) which represent the size of the weights of the individual assets in the portfolio. The horizontal axis captures the rank of the individual portfolios, where the first portfolio is the minimum risk portfolio and the last portfolio is the maximum return portfolio. The vertical axis captures the cumulated sum of weights in the portfolio. The assets are displayed in the same order for each bar, the highest in the bar is always the weight of the WBA assets, then the order continues in accordance with the list next to the chart (CVX, WMT, ...) the lowest is always the weight of the HON assets. From the graphical comparison of the structure of selected portfolios, it is clear that the portfolios obtained by resampling procedures are more significantly diversified in comparison with the classical approach. All the more so in the case of portfolios with higher expected returns located in the right half of the individual figures.

Table 20. Quantified average statistics of selected representative portfolios for each investment horizons and tested model.

Model	Expected return	One-year investment horizon			Three-year investment horizon			Six-year investment horizon		
		Mean	MAD	Sharpe_Ratio	Mean	MAD	Sharpe_Ratio	Mean	MAD	Sharpe_Ratio
„Classical“	0,069%	0,001%	0,839%	0,0007	0,073%	0,431%	0,1693	0,044%	0,572%	0,0776
„Classical“	0,083%	0,002%	0,815%	0,0028	0,077%	0,410%	0,1880	0,037%	0,544%	0,0689
„Classical“	0,118%	0,013%	0,884%	0,0150	0,090%	0,401%	0,2256	0,047%	0,661%	0,0716
„Classical“	0,127%	0,032%	0,906%	0,0355	0,099%	0,417%	0,2364	0,068%	0,670%	0,1021
Norm_mult	0,069%	0,003%	0,823%	0,0036	0,095%	0,356%	0,2668	0,072%	0,462%	0,1553
Norm_mult	0,083%	0,004%	0,813%	0,0049	0,096%	0,370%	0,2583	0,071%	0,454%	0,1557
Norm_mult	0,118%	0,027%	0,863%	0,0318	0,094%	0,382%	0,2460	0,082%	0,658%	0,1253
Norm_mult	0,127%	0,027%	0,924%	0,0295	0,087%	0,449%	0,1945	0,098%	0,696%	0,1404
Gld_mult	0,069%	0,006%	0,790%	0,0072	0,087%	0,356%	0,2448	0,072%	0,448%	0,1598
Gld_mult	0,083%	0,010%	0,788%	0,0121	0,091%	0,365%	0,2496	0,072%	0,455%	0,1578
Gld_mult	0,118%	0,026%	0,867%	0,0305	0,098%	0,382%	0,2557	0,083%	0,611%	0,1363
Gld_mult	0,127%	0,023%	0,918%	0,0247	0,094%	0,458%	0,2058	0,099%	0,665%	0,1486

Table 1 shows the quantified average statistics of individual selected portfolios with the same expected return for individual investment horizons. Portfolios with the same expected return for each model are highlighted in the same color. The best values in

terms of portfolios with the same expected return in individual investment horizons are highlighted. The data show that portfolios quantified using the resampling procedure achieve better results on average. Only in the case of portfolios with the highest expected return does the "classical" approach achieve better value in the first two investment horizons. Portfolios quantified using the resampling procedure and the GLD distribution are, on average, characterized by lower risk, which may favor such portfolios in the case of longer-term investments.

4 Conclusion

The paper deals with the application of the resampling procedure within the process of portfolio selection in the space of expected return and CVaR using the generation of data from a multivariate random variable. The paper contributes to empirical research by analyzing this procedure on daily data using CVaR model of portfolio selection, which have not been the subject of many contributions so far. The paper also describes a procedure using the generation of data from a multivariate GLD distribution, with most of the empirical research to date dealing mainly with multivariate normal distribution. In this paper we deal with the application of two modifications of such a procedure using a multivariate normal distribution and a multivariate generalized lambda distribution. The performed computational experiments show that the portfolios generated by the resampling procedure are more significantly diversified compared to the "classical" approach. A comparison of the performance of individual portfolios within individual investment horizons shows that, on average, portfolios quantified by the resampling procedure achieve better values compared to the "classical" approach. Portfolios quantified using the GLD distribution have, on average, a lower level of risk. Drawing stronger conclusions will require a more extensive analysis, on the other hand, the obtained results stimulate our interest in further future research in this area.

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Sustainable urban development: case study Copenhagen

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Abstract: The aim of the article is to explain the concept of a sustainable smart city with a connection to transport and mobility within case study of green European city- Copenhagen which is generally recognized as a leader in the global green economy. In the first part of the article, we first define the general nature of sustainable urban development and then follow up on the essentials of building urban sustainability, including the role of smart sustainable cities in relation to sustainable urban development. In the second part of the article, we will discuss about effective approaches of the selected European city of Copenhagen, through which we specified in more detail by the case study to specify how successful can smart city be built which is connected with urban transport and mobility which is one of the most important aspect that need to be focused on and constantly improved in order to ensure quality and sustainable urban development.

Keywords: Sustainability, Urban development, Smart city.

JEL classification: *Q52, Q58, R58*

1 Introduction

Nowadays, the main challenge for cities is to optimize the strong dependence on ecosystem services, which leads to the depletion of natural resources, the disruption of biodiversity and efforts to adapt to climate change, giving priority to public health and quality of life. The objectives are, in principle, to reduce the carbon footprint of cities and greenhouse gas emissions, focusing on the ways in which resources and energy are consumed in the construction, operation and maintenance of the urban environment. Such an ideal situation can be created when cities build efficient waste disposal systems, green spaces and green buildings, public transport and attract employers producing organic products from local sources for regional markets. The behavior and lifestyle of urban dwellers play the most important role in building sustainable urban development.

2 Definition of methodology and basic directions in the processing of the article, description of the expected methods applied in the processing of the selected topic

The main output of the article is to approach the issue of sustainable urban development, which in its implementation ensures effective planning to achieve the set goals within the framework of improving the environment. To approach the implementation of strategic plans for the development of urban sustainability, we have chosen a specific European city, in which we will discuss the specific ambitions and results that need to be focused on the development of urban sustainability.

In order to be able to approach the issue of urban sustainable development, we defined the basic aspects of urban sustainability, where we subsequently specified the model of a smart city. Through an analysis by a case study of an ambitious European city - Copenhagen, we put the issue of the topic of the article into practice. They explored specific areas - the smart city with a link to urban transport - that needs to be addressed in order to achieve the development of urban sustainability as effectively as possible. As the most specific goal of the city of Copenhagen is to become a carbon-neutral world city by 2025, we have examined the steps that the city government is taking to bring it closer to that goal as effectively as possible.

To develop the objectives of an article, we draw on available official publications, scientific journals from the Web of Science, Science Direct, Scopus, Springer, Taylor and Frances databases and official statistics published through Eurostat's online libraries, World Bank Database and official documents published by European Commission and United Nations.

3 The essence of sustainable urban development

Urban sustainability is the idea that a city can be systematically organized without over-reliance on adjacent larger cities. The aim is to build a quality urban environment, to create the smallest possible ecological footprint through the efficient use of natural resources, the production of the least possible emissions, the efficient use of land and the recycling of used materials. Sustainability is also about improving livelihoods through social facilities, economic opportunities and health to better suit the capacities of local, regional and global ecosystems.[1]

A sustainable city is an area where there is minimal damage to the environment, the economic base is stable, resources are fairly distributed and working opportunities are secured. It is a city in which there is a strong sense of community and local people are involved in deciding on various issues and problems. Sustainable urban life includes several initiatives, including the use of renewable technologies, energy efficiency, the use of public transport, accessible resources and services. Other important urban sustainability initiatives include: improving the quality of life in the city, including

economic, environmental, cultural, political, institutional and social activities, without burdening future generations. [2]

As part of environmental activity, it is very important for cities to reduce the consumption of natural resources and traces of waste production and to improve land use efficiency so as to minimize negative impacts on the environment. The main representatives of urban structures must consider how to get resources into the city - how far away are the farms producing the basic products they supply to the city, what mode of transport is used to transport materials, how to pump water to the city.[3] The aim of promoting a healthy urban environment in general is to promote the minimization of the burden on the environment, through an efficient and well-developed public transport network, to reduce the need to use cars, to protect biodiversity and to bring nature to all citizens. [4]

Nowadays, modern urban development has an increasing tendency towards a sustainable city model. Residents are showing increasing interest in a healthy environment, affordable services, the possibility of cycling and quality urban public transport. Above all, residents should feel comfortable, safe and have all services easily accessible. The city should provide a healthy living environment in which residents have the opportunity to create strong social communities that are a natural part of their lives. It should be noted that the behavior and lifestyle of the population also play a very important role. [5]

The aim of the article is to explain the concept of a sustainable smart city with a connection to transport and mobility within case study of green European city - Copenhagen which is generally recognized as a leader in the global green economy.

3.1 Smart and sustainable cities

Smart cities are areas where resources are used intelligently and efficiently. They use innovative technologies to save costs and energy, enrich the services offered by the city and especially to increase the quality of life. [6] The main initiative of smart cities is to support economic growth and improve the quality of life of the population through the use of technology. The implementation of intelligent solutions allows cities to use technology, information and data to improve infrastructure and services. Comprehensive development in this way improves the quality of life, creates jobs and increases the incomes of the population. [7]

The basic elements of infrastructure in a smart city include: quality sources of water supply, secured supply of electricity, sewerage, including solid waste management, sustainable environment, citizen safety, health and accessibility of education, efficient urban mobility and public transport, accessible IT connection and digitization, adequate governance, building e-government and citizen participation.

Smart cities strive to be innovative and to bring ready-made solutions in various areas of urban systems. They offer mobile and network services that improve the quality of life of the population. Among the most important aspects that the smart city model focuses on are: mobility, economy, housing, urban management and a sustainable environment. The basis of most of the listed aspects is their interconnection and the

ability to generate data that is intelligently used to ensure optimal use of resources and improve their performance. [8]

The concept of smart and sustainable cities can play an important role in improving cities' carbon footprint by moving to smarter energy use. Through the implementation of innovative technologies, they enable more favorable use of energy in construction, transport, street lighting, etc. They can also facilitate the integration of locally produced renewable energy into the electricity grid. The use of intelligent technologies has a positive impact on the operation of the urban system infrastructure in the construction of intelligent buildings, transport systems, schools, businesses, public services and spaces and other integrations of intelligent urban systems. [9]

This integration serves socio-economic and environmental development, improves the quality of life and addresses the origins of social instability in cities. Digital infrastructure can help integrate different urban infrastructure systems, including energy, water, sewerage or transport, and enable these systems to be effectively managed, controlled and optimized throughout the city. These initiatives also address environmental issues and the availability of human resources. [10]

4 Implementation of strategic goals of sustainable urban development on a concrete example: Case study of Copenhagen

The Copenhagen region accounts for almost 40% of Denmark's production, ensuring stable long-term economic growth. At national level, Denmark's gross domestic product per capita is ranked among the top 10 countries in the world. At the same time, the city has grown while improving its environmental performance and transitioning to a low-carbon economy. [11]

Copenhagen is known as an environmentally friendly city, thanks to effective urban planning, support from national legislation and the involvement of local people in urban planning decisions. It is one of the few cities that excel in its long-term efforts to develop urban sustainability. It is an innovative city, surrounded by water areas with many parks and green areas. An integrated network of public transport and cycling routes provides residents with a variety of types of ecological mobility. [12]

Copenhagen is widely known for its ambition to become a "green, smart and carbon neutral city" by 2025 - a unique ambition that makes the capital of Denmark a model for European cities. Since the UN Conference on Climate Action in Copenhagen, the city has focused its efforts on mitigating climate change. One of Copenhagen's first climate plans aimed for carbon emissions of at least 20% between 2005 and 2015. This goal will be achieved as early as 2011, as a result of which a new climate plan was adopted in 2012. The new ambitious climate plan has the ambition by 2025 to make Copenhagen the first carbon-limited capital in the world.

As part of its ambition for sustainable development, Copenhagen strongly supports the Danish government and its environmental policies. The "Copenhagen model of urban development" refers to a unique vision of urban life combining environmental initiatives, economic growth and quality of life. [13]

4.1 A green, smart and carbon neutral city

In the face of rising rainfall, rising sea levels and rising temperatures in the city center, Copenhagen has developed its own climate change adaptation plan as part of the city's overall climate plan (CPH 2025 Climate Plan). Copenhagen has integrated adaptation to climate change into all aspects of planning, from overall spatial planning to local and sectoral plans. Since the UN Climate Change Conference in Copenhagen, the city has focused its efforts on mitigating climate change. [14]

According to statistics obtained from the gradually achieved goals of the Copenhagen Climate Program 2025, "in the meantime, the city has managed to reduce its impact on the environment by reducing CO₂ emissions by more than 20% over 10 years. It has also been possible to ensure that 30% of energy supply comes from carbon-neutral sources. Although these ambitions are aimed at mitigating climate change, Copenhagen must still adapt to the necessary changes in future weather conditions. [15]

Although these ambitions are aimed at mitigating climate change, Copenhagen must still adapt to the necessary changes in future weather conditions. Precipitation in Copenhagen is expected to increase by 30 to 40% by 2100 compared to the current situation, while water levels around the city are likely to increase by 33 to 61 cm over the next decade. "At the same time, the climate plan ensures that measures are taken in the most efficient and effective way. The city is trying to take proactive steps to improve flood protection against rising water levels. [16]

One and not the last aim of ambitious Copenhagen's climate plan is to reduce transport emissions by 135,000 tons by 2050. The sector accounts for around 22% of CO₂ emissions, which is low given the large city and also the result of the city's previous efforts in this area. More than half of Copenhagen's population says that bicycles are their main means of transport. The ratio of ownership of bicycles to cars is 5: 1, 36% of all trips to work and for education is carried out through bicycle transport. The aim of the climate plan is to increase this value to 50% by 2050, while ensuring that 75% of all roads in Copenhagen are by cycling, walking or public transport. The city also aims to increase the use of public transport by 20% and ensure its carbon neutrality. [16]

Other targets are set for 20 to 30% of all light vehicles and 30 to 40% of all heavy vehicles to run on alternative fuels such as electricity, hydrogen or biogas by 2025. To achieve these goals, Copenhagen is expanding and improving its cycling and public transport infrastructure in various ways, including "green wave" traffic signs favoring cyclists and public transport and rest areas for cyclists at crossroads. [17]

In collaboration with neighboring communities, Copenhagen has begun construction of "bicycle highways" that are wider, smoother and better lit. Some sections consist of three lanes, in order to encourage the inhabitants of suburban areas to travel to the city center by bicycle instead of by car. A total of 26 motorway bicycles were planned for 300 km. [18]

The climate plan was developed in close cooperation with businesses, Copenhagen citizens, NGOs and professional institutions. Due to the necessary revision, new

developments at national and EU level were taken into account in 2016. Local residents are actively involved in implementing the Climate Plan through the use of cycling mobility, sorting household waste, installing solar panels and introducing an energy-efficient lifestyle. With the right approach of the people of Copenhagen to the protection of the environment, they create added value in improving their surroundings. At the same time, there is a benefit in the form of savings on energy consumption, with residents saving more than DKK 4,000 (EUR 536) per year. The climate plan will have a positive economic impact, as energy savings will offset any increased costs of producing and transporting energy. It will benefit both businesses and households: a couple with one child living in an apartment, with one car, could save DKK 6500 (EUR 872) a year. [19]

4.2 Ways of using urban mobility

In terms of urban mobility, Copenhagen is clearly a successful example of managing and using urban mobility. As a result, the Danish capital is considered the "European Capital of Cycling". Despite an ever-growing population, approximately 1,000 inhabitants per month, the city is successfully in optimizing the use of car mobility. [20]

As we have discussed in the previous section, one of the main objectives of the Copenhagen Urban Development Plan is to make the mobility of the population through the use of bicycle transport exceed the use of car mobility. According to the statistics of the World Economic Forum 2018, there were 675,000 bicycles and only 120,000 cars in Copenhagen, which means that the ratio of the number of bicycles to cars exceeds the discussed ratio of 5: 1. Almost 29% of the mobility of people around the city is realized by bicycle, while commuting to work and education represents a value of 41%. In 2016, Copenhagen cyclists drove a total of 1.4 million km every day. This is an increase of 22% since 2006. [21] One of the main reasons for the popularity of cycling in Denmark is the quality network of cycle paths, including the innovative bridges that make up the cycling highways throughout the city. This may be the key to understanding why Copenhagen is also one of the safest places for cyclists. Between 2006 and 2016, cyclists' sense of security increased from 53% to 76%. The city council has the ambition to achieve security up to 90%. [23]

Norrebrogade, the cycle path and also the main radial street from the suburbs to the city center represent an important connection for cyclists to the city center as well as to the surrounding areas. It is also a central shopping district in a densely populated modern area. It used to be an ordinary city district, where you could drive at a maximum speed of 50 km / h. In both directions there were two lanes for cars and one bike path in places as narrow as a sidewalk with a width of two meters. In both directions there were two lanes for cars and one bike path in places as narrow as a sidewalk with a width of two meters. Approximately 40,000 cyclists travel along its route daily. [22]

To increase the speed of travel for cyclists, a "green wave" for cyclists was set up in Norrebrogade in 2006. In most cases, green waves are planned to promote smooth car traffic. In Copenhagen, this principle was changed to promote smooth cycling. Green waves were introduced in the three streets of Norrebrogade, Osterbrogade and Farimagsgade.

Nowadays, a total of approximately 1,000 km of cycle paths are available in the city area. Of this, only 200 km are high-speed cycle routes (so-called Cykelsuperstier), which are developed and designed to motivate residents to prefer cycling. These bike paths are three meters wide and the traffic lights along them are synchronized to create a green wave and ensure that cyclists do not have to stand at intersections. The main motivation of the population to use bicycle transport is the fact that it is faster, more comfortable, cheap and healthy. However, cycling has an obvious environmental effect, which reduces CO₂ emissions, air pollution and noise reduction. [23]

The development of sustainable urban mobility in Copenhagen also aims to raise awareness of pedestrian mobility. The aim of the Copenhagen Pedestrian Strategy is to encourage the population to promote pedestrian mobility. There are many good reasons for this: pedestrians help to create a livelier and more diverse city that is safer for everyone, encourages residents to engage in daily activities, induces mental and physical well-being, provides space for socialization and, among other things, is environmentally friendly. [24]

In 2008, Copenhagen signed the International Walking Charter, with the aim of creating healthy, efficient and sustainable communities that support walking within the city. Since the signing of the charter, the city has developed a strategy in close cooperation with the residents themselves, who are actively involved in the design of new walking routes and shortcuts. The city focuses on four main priorities: developing a culture of walking, creating pedestrian paths and meeting spaces, and increasing the attractiveness of shopping streets and transport hubs such as stations and bus stops for pedestrians. The aim is to provide pedestrians with safer conditions with clean sidewalks and public spaces where people can enjoy the street urban atmosphere. [25]

An integrated public transport network is successfully developing in Copenhagen. Local trains, the metro and the high-frequency bus network form the basis of Copenhagen's public transport system. A sign of the expansion of integrated public transport in Copenhagen is the expansion of the city ring road network - "Cityringen". Its construction began in 2011 with a planned completion by 2019. The new circuit is expected to carry around 234,000 passengers on weekdays, add 3,000 new routes in the wider Copenhagen area and about 3.4% more routes via public transport. The aim of the construction is to increase the quality of the infrastructure and help to develop the city center. Simultaneously with the construction of the new metro circuit, the rest of the public transport infrastructure is being modified in order to ensure the best possible interaction between other modes of transport - bus, bicycle and rail transport.

In addition, the city is improving the availability of buses on sections of the central road. Special lanes are being set up for buses, stops are being provided for the high-frequency bus network, shelters and real-time information on bus arrivals are being improved. In addition to physical initiatives to develop integrated public transport, the city also works to influence traffic habits through campaigns, brand building and information provision. The city is especially focused on the above-discussed bicycle traffic, where the "I bike CPH" brand dominates. The last cycling campaign was to spread "good cycling karma" by distributing chocolate. The city is constantly working on new transport plans for all spheres, in order to encourage residents to change their transport habits. [26]

In Copenhagen, trains and the metro are considered to be the lowest CO₂ emitting modes of public transport. Their CO₂ emissions per passenger km are less than half that of buses. The number of passengers by public transport is approx. 750,000 passengers per working day and just under half will be transported by train and metro. The city is constantly working to reduce traffic collisions, for example by introducing congestion charges. This step would help reduce car traffic in the city. The city has also changed and expanded its parking strategy to reduce suburban traffic in particular. [27]

The areas of paid parking spaces are increasing and with them the prices for parking. Among other things, the 2009 urban planning introduced a set of parking standards to ensure that Copenhageners can park their cars close to their homes and thus limit car mobility. In addition, the city seeks to promote the use of car-sharing systems and the availability of reserved parking spaces for licensed vehicles. Finally, as part of the city's road network plan, the city has adopted the principle that car mobility should primarily take place on main roads and that roads should be designed to suit their function. For example, the roads of the main street of the city center, Nørrebrogade, are proposed to be left without traffic and to improve conditions for pedestrians and cyclists.

As part of the city's initiative to ensure the environmentally friendly use of fuels, the city provides laboratory testing for hydrogen and biofuels. By 2015, 85% of city passenger cars were to be powered by electricity or hydrogen. By 2025, the goal is for 20-30% of all passenger cars in the city to be powered by hydrogen, electricity or biofuels, with five hydrogen filling stations in the Greater Copenhagen area. Greater use of fuel cell electric vehicles (FCEVs) will bring a number of benefits, including better air quality, reduced noise and the absorption of excess wind energy. FCEV fuel cells will be integrated into a car association system with training to help users handle vehicles. [28]

Overall, developments over the last 10 years have gone in the right direction. The ratio of bicycle and public transport to car transport has increased, although the population is growing and more jobs are being created. For many years, the city of Copenhagen has sought to improve conditions for cyclists in the city and to encourage residents to make cycling a priority for mobility within the city. And that is exactly what they managed to achieve. Since 1998, the number of kilometers traveled by bicycle has increased by approximately 30% and this value is constantly increasing. An effective tool to support political decisions were the so-called Cycling and Traffic Accounts under the common name "Green Accounts", which assess the city's initiatives, the achievement of goals and the views of the city's residents. Through these acts, the direction the city is taking is very clear. Especially if we evaluate whether the initiatives are working according to plan. Competent politicians and officials can use this to tailor and develop future initiatives.

For example, Cycling Accounts clearly show the importance of effective campaigns, visible signage and other more communicative initiatives following physical changes in urban areas. The most effective impact of the achieved changes occurs only when the physical and visual side complemented by the campaigns has effective effectiveness. [29]

5 Conclusion

Cities are strategic areas in a global context in terms of economic wealth and innovation, but they are also places where social and environmental pressures are intensifying. The urban planning system is an expression of how local governments can regulate the link between the objectives of economic development, the environment and the quality of the urban environment.

The diversity of planning systems and practices is the result of the historical and geographical development of specific cities and the way in which they are linked to national institutional structures, culture and economic opportunities. However, the way in which economic development, the quality of the environment and the quality of life are linked to local strategies is important for the overall economy and environment.

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Effects of Industry 4.0 on Human Capital and Future of Jobs

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Abstract. The ever-increasing digitalization, automation and robotization of business processes will lead to a proliferation of workplaces with a high level of complexity, which will lead to the need for continuous staff training. The challenge for businesses will be able to adapt to changing environmental conditions to remain competitive. Despite increasing attention being paid to the job and skills changes brought about by Industry 4.0, research in this area is still scarce. The aim of the present theoretical research is therefore to introduce the issue of Industry 4.0, and its impact on the workforce and the future of jobs. Through the available domestic and foreign literature, we have provided a theoretical overview of recent studies, that address the issue of the impact of Industry 4.0 on the labor market. Findings point to trends in the disappearance of certain jobs and the creation of new jobs, that concept of Industry 4.0 offers in the form of opportunities. Our search also resulted in a summary of the worker's competences, which meet the requirements of the Industry 4.0 era, as well as a set of key solutions for businesses in human resource management.

Keywords: Industry 4.0, Human Capital, Future of Jobs.

JEL classification: M12, M19, M29

1 Introduction

The topic of the Fourth Industrial Revolution, the evolution of jobs, and consequently changes in human capital issues is of increasing interest to researchers [8], policy makers [42], and managers from corporate practice [30]. Adoption of the automation and technologies in digital environment in manufacturing – like cyber-physical systems, cyber-security, Big Data, augmented reality, Internet of Things, cloud computing, simulation, robotics, additive manufacturing, systems integration [34] - predict to significantly affect work processes and the work environment [20]. The new

era will lead into changes within jobs in terms of content, and new job occupations will emerge. Based on the above fact, higher skill requirements will be demanded from employees [15,42]. Despite increasing attention being paid to this topic, research addressing the impacts of the fourth industrial revolution on jobs and skills is lacking [8,16].

What will the further development of the industry look like? Will further development offer new job opportunities or destroy jobs? What will the further development of job profiles look like? And what categories of skills will be in need? The answers to mentioned key questions will need to be replied by business leaders and policy makers to seize the opportunities presented by Industry 4.0 by ensuring an adequately skilled workforce [30]. As a result, the qualifications and skills of the workforce needed to meet the demands of the modern era will vary significantly [7,18,25,26].

In the following theoretical research, we will focus on the emerging changes triggered by the impact of Industry 4.0 on the workforce, and we will also discuss the topic of the future of jobs. Through a study of the literature, we will provide answers to the individual research questions within the framework of the issue at hand.

2 Literature Review

2.1 Four Industrial Revolution

The concept of the fourth industrial revolution, otherwise known as Industry 4.0, was first introduced at the Hannover Messe in 2011, captivating not only manufacturers but also the scientific community [39]. The scientific literature characterizes the concept Industry 4.0 in different ways. One group of authors explain Industry 4.0 [19] as the digital integration of manufacturing processes, in which processes of production are automated and products, services and equipment are connected. Ongoing revolution is run by the Internet, through which not only human being but also machines will be in contact in a cyber-physical system. Other authors [48] argue that the evolution of manufacturing processes is run by market demand for more effective technologies and processes, cost reduction and quality standards, or technological advances. According to Qin and Liu [29], Industry 4.0 performs a significant role in intelligent data collection and interpretation, proper decision making and its timely implementation, which will result in faster data collection and interpretation procedures. Industry 4.0 is a trend of automation and data exchange in manufacturing technology. While the third industrial revolution (Industry 3.0) concentrated on the automation of specific business processes, Industry 4.0 focuses on the digital transformation of companies. This implies a comprehensive digitization of all physical assets and the creation of another digital environment, including the value chain [40]. The generation, analysis and seamless communication of data represent the core benefits, that Industry 4.0 brings, with the aim of bringing together a wide scale of innovative technologies to create value. In the context of Industry 4.0, modern technical systems will be intertwined with processes of organization to transform industries, which will lead into the interconnection of people, machines, and smart objects in real time [5, 6,17, 44].

The idea of Industry 4.0 is attractive in many countries and businesses. This is supported by programmes implemented by national governments, such as "Industrie

4.0" in Germany, "Made in China 2025" in China, "Smart Factory" in the UK, "Advanced Manufacturing Partnership" in the USA [27] "Smart Industry Concept" in Slovakia [35] and many others. However, the implementation of innovative technologies such as those brought about by Industry 4.0 is challenging and complex, especially for developing countries and industries or areas with a lack of technological advancement [38].

Thus, we can say, that Industry 4.0 unconditionally produces new opportunities for businesses, but at the same time many challenges arise from the continuing automation and digitalization [17].

2.2 Consequences of Industry 4.0 for human capital

It is clear, that the work performed by skilled labor in the workplace of the future will be very different from the situation in those of today. Based on the above, the qualification needs and skills of the skilled workforce, that will be necessary to perform tasks in companies responding to Industry 4.0 requirements will also differ [1,18,45]. The study by Gehrka et al. [8] proposed an approach to develop recommendations for the qualifications and skills of the future worker under Industry 4.0 conditions. The approach is based on a three-level analysis. The first level consists of four factors, that have a significant impact on human capital and will significantly change the way businesses operate in the future. These are: tools and technologies, organization, and structure, working environment, intra-organizational and inter-organizational cooperation. The first level factors determine the second level, which represents skilled labor tasks. The third level is the skills and qualifications of the workforce, which builds on the second level. More specifically, the qualifications and skills required for a skilled workforce to perform a job effectively are determined primarily by the job tasks.

The costs associated with workforce training are just one of the other elements, that businesses need to allocate their financial resources to [13]. Before the actual introduction of automation and robotics, companies should implement many changes - from technology to human resources. Important changes include, for example, changes to existing production systems and models in companies [32]. An important change will be to adapt workers' skills to the demands of processes of automation, including reconfiguring training programmes to support workers acquire the necessary digital and soft skills, and substituting current processes and systems with ones, that are better suited to adapting to innovative technologies, as well as providing temporary support for those, who will lose impact due to automation [32,41].

The innovations coming with the Industry 4.0 era will also change the relationship between workers and employers. Tasks, projects, that are distributed through cloud platforms will be carried out by independent workers. These include professions such as: UBER driver, or Airbnb host. In the process, they will not be subject to obligations such as minimum wage, employment tax and social insurance as for those classified as self-employed [28].

The employment threat is the concern, that robots will substitute human workers in the future, which lead to increasing unemployment. However, rather than arguing, that the production of robots will result in unemployment, the workforce needs to

acclimatize to the needs of the new age and exploit its potential in areas such as robotics and automation, on the one hand, and areas such as the social sciences, anthropology, the service sector, the field of organic products, agriculture, education, the livestock trade, and the technology trade, on the other hand. New professions, new processes, new production methods, new products and innovative technologies are to be created by people. The revolution of the production process into a digitalization process will not only have negative consequences, quite the opposite. Common workers, managers, and entire companies should react to this process with a strategy of transformation and groundbreaking changes [28].

Based on current trends and experiences from previous industrial revolutions, it is clear, that the impact of Industry 4.0 on the workforce is inevitable. Every industrial revolution has brought efficiency and productivity gains [47]. According to some researchers [11], there is a significant displacement of human labor from an increasing number of jobs [12], which may lead to the trend envisioned by Keynes and known as "technological unemployment" [24]. Mentioned theory states that technological progress will substitute human jobs more rapidly than can create new ones [3,24]. In contrast, other research papers describe positive changes associated with the increase of automation. In the researchers' understanding, the preservation of human health will represent a greater benefit in the long run [4]. For example, the mentioned benefits related to automation are replacement of hazardous and risky jobs, better quality, higher safety, lower costs, and ecologically friendly solutions [9]. According to some views, the automation of the workforce does better than harm, as machines take over responsibilities, that are potentially unsafe or harmful for workers, such as welding or painting cars. In addition to mentioned points, some duties or jobs could also be supplemented by technological solutions, such as the use of virtual reality to decrease possible accidents to zero, or even the enforcement of sensor-driven quality control on production lines to replace monotonous work [4,9,21,31].

Based on the study by Szabó-Szentgróti et al [47], we can divide the positive and negative effects induced by Industry 4.0 in the context of human capital into the following table:

Table 21. Positive and negative effects of Industry 4.0

Positive Effects	Negative Effects
More free time	Rising structural unemployment and inequality
Replacement of human labor with technology does not automatically mean a reduction in employment opportunities	Reduction in the number of job opportunities
Rising productivity, creating new jobs	Shortage of experienced people for an constantly changing labor market
Cost-effective and ecological aspects: higher quality, improved safety, ecologically friendly solutions, replacement of hazardous jobs	Slowdown in global economic growth
Cost reduction	New skills and training requirements

3 Aim and Methods

The aim of the theoretical research is to raise awareness of Industry 4.0 through scientific literature and articles and to highlight the changes in human capital brought about by the impact of the new phenomenon, as well as to draw attention to the future of jobs and the changing labor market.

To analyze the issue at hand, we will use available domestic and foreign sources, that explain in detail the topic of Industry 4.0, changes in the field of human resources in the context of the impact of Industry 4.0, and the future of job positions. With the help of the acquired information, we will arrive at a theoretical explanation of the issue.

We applied basic scientific methods to develop a theoretical paper. We have used: analysis, synthesis, generalization, induction, and deduction. From the information gained, we have developed a significant theoretical knowledge base on the future of human capital and jobs, that meet the requirements of Industry 4.0. Through a thorough analysis of the issues addressed, we arrived at the following research questions:

1. What changes will the pressure of digitalization, automation and robotization cause in jobs? What jobs will disappear and what jobs will be created?
2. What competencies are required from the workforce in Industry 4.0?
3. How should companies respond to the increasing pressure of Industry 4.0?

4 Results

The widespread use of robotics, automation and digitization will have significant consequences for competences, jobs, skills, and professions. The improvement of Industry 4.0 will be supplemented by changes in the roles and requirements of workers in the companies [10,46]. Industry 4.0 will present many opportunities, but also risks connected with it, such as the lack of fundamental changes in labor market governance and the socio-ethical dimension of implementing the breakthrough concept of Industry 4.0. Thus, the biggest challenge of Industry 4.0 will not be technology, but people [43]. Therefore, in the following part of the theoretical research we will reply to the individual research questions, in which we will approach the problem of the impact of Industry 4.0 on human capital:

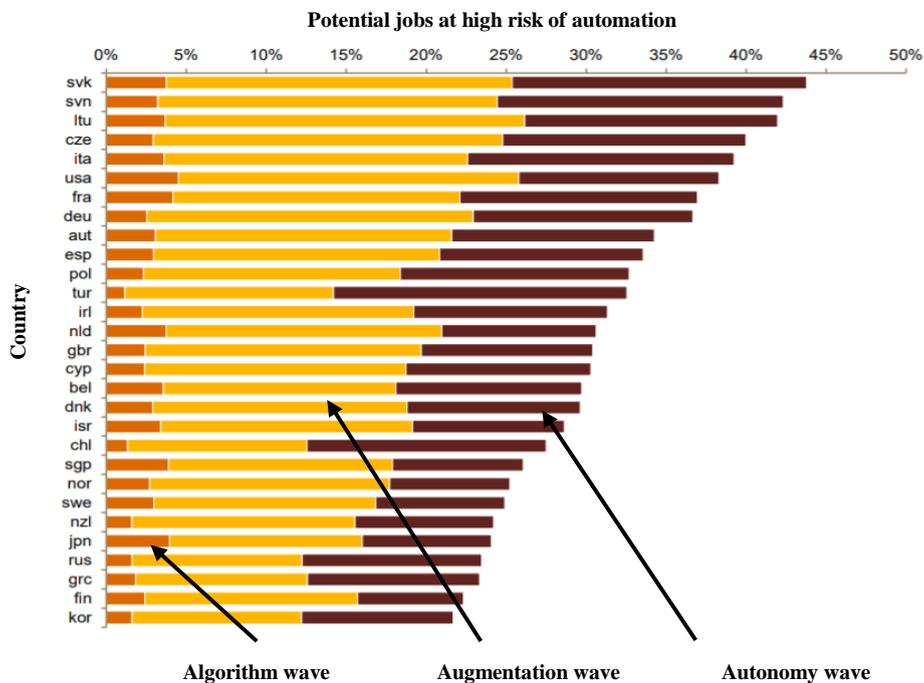
1. What changes will the pressure of digitalization, automation and robotization cause in jobs? What jobs will disappear and what jobs will be created?

Robotics, artificial intelligence, and more forms of automation are improving at a rapid pace and have the possibility to bring major benefits to the economy by increasing

productivity and creating brand new and better products and services. A PWC study says, that new technologies could add up to 14% of GDP by 2030, or around \$15 trillion. These prognoses will also lead into the labor market. The study goes on to outline, how the whole process of implementing Industry 4.0 will evolve in three overlapping waves by 2030:

- **Algorithm wave:** aimed at automating simple computational assignments and exploring structured data in areas such as information communication finance. This wave is already underway.
- **Augmentation wave:** aimed at automating monotonous duties such as form filling, communication and information exchange through technology support, and statistical analysis of unstructured data in semi-controlled environments like robots and drones in warehouses. This wave is already underway but is likely to reach full maturity in the coming period.
- **Autonomy wave:** aimed at systematizing physical work and manual dexterity and problem solving in dynamic real-world situations ,that require agile responses, e.g., in manufacturing and transportation (driverless vehicles). This wave will reach its peak in 2030 [41]

Automation will disrupt labor markets, but its impact varies considerably from country to country. Eastern European economies are the most dominant (over 40%), where manufacturing, which is usually simpler to automate, still accounts for a



relatively high share of total employment. The figure below shows the potential rate of job automation by country in each wave.

Fig. 1 Potential job automation rates by country across waves

Source: PWC. Will robots really steal our jobs? An international analysis of the potential long term impact of automation, <https://sci-hub.se/10.1109/ITMS51158.2020.9259295> , last accessed 2021/8/6 (2019).

A study by the Mckinsey Global Institute [33] adds that between 400 and 800 million workers worldwide will be replaced by automation by 2030. The activities most susceptible to automation include physical activities in predictable environments, such as operating machinery or preparing fast food. Data collection and data processing are other categories of activities, that can be performed increasingly better and faster with the help of machines. It would replace a large amount of work such as mortgage lenders, accountants, back-office activities. The workforce will have to adapt to the new conditions and change careers, and learn the new skills needed. The MIT Technology [36] study adds, that Industry 4.0 will change the environment of many jobs and create new jobs in the future. It will also offer new opportunities for workers with qualifications and skills related to the new technologies, that make up the Industry 4.0 concept. The impact of the intense pressure of the ongoing revolution has led into new jobs, that are increasingly appearing on the job market, such as: growth hackers, data scientists, customer specialists, artificial intelligence specialists, wind turbine service technicians, social media assistants, landfill biogas systems technicians, green marketers.

In the next three years, more jobs are estimated to be added in emerging occupations. Increase will be seen in care giving (37%), sales, marketing, and content creation (17%), data analytics and artificial intelligence (16%), engineering and cloud computing (12%), and culture (8%). Current prognoses for occupations associated to ecological protection and climate change stay low. Only 117,200 new jobs (1.9%) are supposed to be created globally between 2020 and 2022 [13].

According to a study by the World Economic Forum [50], it is predicted that around 54% of employees will need to retrain or upskill by 2022. Professional skills, including analytical thinking and innovation, as well as effective and purposeful learning, will carry on gaining in importance. Employers cite workforce training as one of their top priorities. Around 50% of them need their current workforce to stay in their jobs and use innovative technologies in their work, which means, that they do not plan to make redundancies. In addition, 41% want to distribute funds for staff retraining and 33% said they would only fund training for those workers, who need retraining and upskilling.

Increased technological progress will lead to a significant increase in productivity, decreasing the number of employees needed to reach a given level of output. Though some jobs will disappear, the level of collaboration among people and technologies will increase drastically [30]. Work will be able to be done in efficient places in more efficient times, respecting the needs of the employee, the customer, the individual and the whole team [22]. It will also provide new opportunities for the integration of people with physical disabilities [23].

2. *What competencies are required from the workforce in Industry 4.0?*

The automation and digitalization of the economy will lead to the requirement of upskill workers in industry. Increasing digitalization will make manufacturing processes more challenging and complex [49]. Grzybowska, Lupicka [14] present the results of a survey in selected companies in the automotive and pharmaceutical industries, where eight core competencies, that meet the requirements of Industry 4.0 are listed. These are: entrepreneurial thinking, conflict resolution, creativity, problem solving, decision making, research skills, analytical skills, efficiency orientation. The research highlighted the significance of knowledge improvement as an indicator of the potential of the company. Workers with business thinking skills are particularly needed, because they have a tendency to think innovatively, take responsibility for their work and are productive. This finding also emphasizes the importance of developing creativity and creative thinking. The importance of skills related to decision-making, problem-solving, conflict resolution and efficiency orientation is emphasized. This thinking is probably based on the notion, that the ability to make most advantageous and effective decisions is the only way to improve productivity and acquire strategic advantage. In the study by Hernández de Menéndez [31] points to technical, methodological, social, and personal competences. Technical competences represent media, coding, technical skills, understanding of IT security and continuous acquisition of the latest knowledge. Methodological capabilities represent creativity, entrepreneurial thinking, problem solving, decision making, conflict resolution, analytical skills, research skills, and efficiency orientation. The social competence group includes intercultural skills, language skills, communication skills, teamwork skills, networking skills, ability to compromise, and leadership skills. Personnel capabilities consist of flexibility, tolerance of ambiguity, ability to work under pressure, motivation to learn, sustainable thinking, and compliance.

Generation Z students (people born since 1995) are entering the labor force. This generation has qualities, that fit the emerging technologies of Industry 4.0. Their habits are different from previous generations; they choose 'cool' products instead of 'cool' experiences, they are business and tech-savvy, and they like to co-create culture. In particular, the competencies required of them include cultural and intercultural skills, interdisciplinary thinking, decision-making, lifelong learning, problem solving [2], and processing typical technologies of Industry 4.0 [37].

There is no consensus on well-defined competences responding to the Industry 4.0 environment. However, a critical competency, that future professionals must possess is the ability to use their knowledge in different areas of collaboration to add value. Businesses need to take into account, that employees need to acquire new competences by providing training programmes, that continuously support their development [31].

3. *How should companies respond to the increasing pressure of Industry 4.0?*

According to a study by Lorenz et al. [30], businesses should be able to requalify their employees frequently to keep up with the introduction of technological advances. Though many of them have programs in place to retrain employees, these attempts will

need to be extended and sophisticated. Efficient training programmes for specific work-associated skills should include on-the-job training (e.g., using augmented reality or observing experienced workers performing the task) as well as classroom instruction. Given the scale and range of retraining needed and the need for staff to flex their time, it will be essential to offer training programmes online. There will also be a need for training in a broader set of skills, as many staff will be working on a larger range of assignments. Fostering a positive outlook on change among workers will be needed to enable them to adjust to new processes and tasks. Concept Industry 4.0 is generating new types of connections among humans and machines – interactions, that will have a significant effect on the essence of work and organizational structures. To accommodate the increased variability of production schedules, businesses should consider new working models, that incorporate flexible schedules. Businesses will also require reorganizing decision-making powers. For example, a robot coordinator should not wait for directions from a manager before authorizing a robot to start emergency renovations to production machinery. In many cases, it will be beneficial for businesses to implement flatter organizational structures to handle more scattered use and control of data. Industry 4.0 will also need closer incorporation between the IT company and operations departments, so that software developers completely know how their solutions are worked in production and operators understand how these solutions impact their production lines. Interactions among developers and operators must therefore be designed to ensure, that complex IT tasks are handled seamlessly. Businesses must also make sure, that their staff stay responsible for innovation and coordination of complete processes, rather than trying to automate those processes. If businesses want to achieve in Industry 4.0, they should reflect new approaches to recruitment, that focus on skills rather than qualifications defined by titles and roles. As workers will be working on more tasks, that are not related to their basic education, recruiters will often need to look beyond formal titles to identify workers with the appropriate skills for specialized tasks. This means, that producers should highlight relevant qualities and skills in job specifications, as formal titles and education are less relevant. For example, rather than looking for a mechanic who is specialized to carry out a particular repair, manufacturers should look for a mechanic who is open to change and has knowledge in repairing machines during production hours, specific experience of working with a particular brand of machine and experience of using certain kinds of IT interfaces. To meet the various tasks ahead, companies need to pay considerable attention to 'strategic workforce planning'. This work starts with the systematic gathering of simple information on all workers and the classification of different types of workers into workgroups. Mathematical modelling can be used on the supply side to gain insights on attrition and retirement, and on the demand side to replicate workforce requests given the anticipated rates of Industry 4.0 implementation, productivity improvements and revenue growth of the company. The outputs from the supply and demand models can then be combined to create a complete gap analysis, that will provide insight into the necessary actions, such as people development, redeployment, insourcing or outsourcing, and the implementation of new recruitment targets, that businesses should adopt.

5 Conclusion

The progress of innovative technologies brings about improvements in the quality of life of people and the well-being of society. It is a major driving force in today's global economy [14]. Industry 4.0 connects people, systems, and objects to form optimized, dynamic, self-organizing, value-creating inter-enterprise networks, that affect all company processes. Despite of, most companies hesitate to start digital transformation processes due to significant barriers to implementation, which include uncertainty of financial benefits and lack of expertise [37].

The results of our theoretical research point to the essence of human capital in Industry 4.0 and the effect of Industry 4.0 on the future of jobs. The most significant finding of the theoretical research is, that the next decade will see the rapid replacement of monotonous simple jobs by automation, digitization, and robotics, but the impact of the strong pressure of the ongoing revolution will also lead into new jobs and offer interesting opportunities in the labor market. To be employable in the labor market, future employees will need to have future competences such as decision-making, problem-solving, cultural, and intercultural skills, interdisciplinary thinking, lifelong learning and the handling of standard Industry 4.0 technologies. To accelerate the whole process, companies will also have to respond by retraining their employees, adopting new working and organizational models, recruiting for Industry 4.0 issues, and implementing strategic workforce planning.

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Evaluation of the company's environmental behavior through environmental management indicators as part of environmental reporting

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Abstract. The development of the approach of organizations to environmental protection went through several stages from the passive approach, which relied on the power of nature to dispose of waste by its own assimilation ability, through the so-called. a reactive approach, based on a control and management strategy, mainly in connection with the adopted legislative measures up to the preventive principle. It is based on the fact that preventing the occurrence of environmental pollution is cheaper and more effective than removing it or bearing its consequences. Instead of focusing on control and management, the focus has been on finding ways to prevent negative phenomena. Businesses demonstrate their environmental responsibility in a variety of ways, such as implementing environmental policy, implementing environmental management systems, environmental audit and publishing their environmental reports. Many of the companies that care about the environment have this information published on their Internet portals, where it is available to the public.

Keywords: Environmental reporting, environmental management indicators

JEL classification: F6, Q5

1 Introduction

Reporting on sustainability in the organization's practice is called environmental reporting. Through this process, the organization identifies its significant environmental impacts and discloses them in accordance with a globally acceptable standard. The information provided through sustainability reporting enables internal

and external stakeholders to form opinions and make informed decisions about an organization's involvement in achieving sustainable development. [5] One of the new trends in reporting is so-called integrated reporting. The company does not prepare two separate reports (financial and non-financial), but one, which includes all mandatory financial information and also shows the company's results in the field of environmental protection and its impact on society. Reporting on non-financial results reaches the same level and presents that the primary goal of the company is not only to focus on making a profit, but also its goal is a positive impact on the environment, innovative benefits and provide work for employees. It is a matter of course for larger companies to have these reports verified by an independent auditor. Just as the credibility of financial reports is enhanced by the verification of financial results by financial audits, the results in the area of non-financial information presented in the annual report are subject to the auditor's opinion. [1]

2 Environmental reporting

The Slovak Republic adopted an amendment to the Accounting Act, in 2015 on the basis of Directive 2014/95 / EU on the Disclosure of Non-Financial Information and Diversity Information. However, non-financial information should be disclosed only by public interest firms with an average number of employees over 500. Although only large companies are required by law to report on non-financial indicators. This covers approximately 11 700 large companies and groups across the EU, including:

-listed companies

-banks

-insurance companies

-other companies designated by national authorities as public-interest entities. [4]

CSR reporting can also bring benefits to small and medium-sized enterprises. [7]

Producing an environmental report can bring a number of benefits:

1. reputation — publishing an environmental report informs all stakeholders that an organisation is transparent about its environmental performance and confident about its future strategies.

2. legal requirements — the environment report acts as a benchmark for legal compliance, highlighting particular aspects that may require extra vigilance

3. robust data analysis — key performance data gathered to produce a report can help improve environmental management, minimise risk and identify opportunities for resource savings and operating costs

4. employee recruitment — companies with good environmental performance reporting are more likely to attract and retain high-calibre employees

5. increase market share — large organisations and businesses are requiring their suppliers to issue environmental reports as a way of tracking whole-life cycle impacts of products and services. Environmental reporting can also help organisations manage their supply chains more effectively. [2]

3 Environmental indicators

Environmental management indicators / indicators enable us to measure the company's environmental behavior and compile an environmental report. Environmental indicators are a set of indicators for evaluating the effectiveness of an environmental management system. Through them, we can also monitor their development as well as the company's efforts to improve its environmental profile. We can use the indicators within the EMS to control the fulfillment of the set environmental goals of the company. Environmental management indicators allow the company to monitor over time how its environmental behavior develops and also whether the company is in compliance with applicable legislation regarding the activities that the company performs. It can use indicators to identify areas where greater efforts are needed to prevent and protect against environmental pollution. A change in the value of the indicator is a signal that can indicate, for example, a problem in the production process. Information on environmental behavior is important for both managers and employees and other stakeholders. Indicators are important in compiling the company's environmental report, which serves to present the company's environmental behavior to stakeholders and thus positively influence the image and reputation of the company / brand.

Environmental indicators should be selected to meet the following attributes:

- cover all relevant environmental aspects,
- take into account the environmental laws to which the undertaking is directly subject,
- take into account the interests of stakeholders,
- take into account the environmental policy objectives of the undertaking,
- served for the needs of the target group. [3]

3.1 Areas of corporate environmental indicators

The structure of a company's environmental indicators depends on the system (such as ISO, EMAS) according to which the company decides or needs to develop its plan of corporate environmental indicators.

Environmental indicators according to ISO

ISO has developed an ISO 14031 standard aimed at assessing environmental performance using corporate environmental indicators (Environmental Performance Assessment - EPE). The EPE method collects and analyzes data, provides information suitable for benchmarking, annual business reports (reporting) or communication with various stakeholders. The ISO 14031 standard makes it possible for companies to monitor the set long-term and short-term goals through the possibility of creating a set of their own environmental indicators, in the following areas:

a) The operating area consists of business activities that have an environmental impact

aspect. Indicators used to measure environmental aspects from production activities are called operational environmental indicators, which include:

- total amount of energy consumed per year,
- water consumption per unit of production,
- waste generation per year,
- NO_x emissions per unit of production,
- and others.

b) The area of management consists of planning, decision - making organization and control. Managerial decision making related to the environment includes:

- the amount of money spent on environmental activities,
- number of employees participating in environmental training management, or audits, etc.,
- the issue of developing and implementing an EMS,
- and others.

Indicators related to the management of environmental activities are called **managerial environmental indicators**.

These are, for example:

- achieved environmental goals and values,
- number of informed suppliers / customers about the environmental management and behavior of the company,
- frequency of inspections and audits on the production process,
- number of employees who participated in environmental training

c) The financial area includes financial indicators that assess the effects of environmental activities on the financial situation of the company. They can be used to control the costs associated with environmental activities and / or the publication of environmental reports. This is information related to:

- costs of environmental activities,
- ROI from environmental projects,
- achieved savings from waste recycling and reduction of used materials,

Financial managerial environmental indicators contribute to a better understanding of the links between the company's financial situation and environmental behavior. Some indicators may point to problem areas and therefore require increased attention. Operational environmental indicators, together with managerial environmental indicators, are called corporate indicators of environmental behavior. Their monetary as well as in-kind expression makes it possible to read almost accurately from environmental management accounting.

d) the area of environmental conditions and its indicators are measured in the monitored

environmental conditions. Belongs here:

- concentration of contamination in air, water, soil, plants and animals,
- odor at a specific distance from the company, etc.

Categories of EMAS environmental performance indicators:

Table 1 Operational behavior indicators [3]

Input indicators	Indicators of physical facilities and equipment	Output indicators
Materials	Design	Products provided by Organization
Energy	Equipment	Services provided by Organization
Support services for operation of the organization	Operation	Waste
Support products for operation of the organization	Maintenance	Emissions
	Land Use	
	Transportation	

Table 2 Managerial Behavior Indicators [3]

System indicators	Functional area indicators
Implementation of policies and programs	Administration and planning
Compliance	Purchases and investments
Financial behavior	Health and safety
Employee involvement	Community relations

Table 3 Environmental conditions indicators [3]

Environmental components	Biosphere and atmosphere indicators
Air	Vegetation
Water	Animals
Country	People
	Aesthetics, heritage and culture

3.2 Types of corporate environmental indicators

We know four types of indicators:

Absolute - CO₂ emissions t/year, waste produced t/year, water consumption m³/year. It is important to know the values per unit of production so that the company knows if it is a real improvement. The fact that e.g. emissions decreased in year 2 compared to year 1, it may be due to a decrease in production and not better environmental behavior.

Relative - the amount of emissions to the total output, water consumption per unit of production, the amount of waste produced to the total material consumption, etc.

Aggregated - produced waste per year, total consumption of energy, water, gas, number of km/year traveled, etc.

Weighted and indexed are used to distinguish the severity of individual environmental aspects. The company chooses the evaluation scale itself. For index indicators, the value for the current year (numerator) is compared with the selected, base year (denominator). A value less than 1 indicates an improvement in the indicator compared to the baseline period.

4 Conclusion

Environmental reporting is an excellent means of communication for every organization. It is a comprehensive environmental "annual" report by which the organization informs the public and all stakeholders about its relationship with the environment, including the quantification of environmental impacts and the measures it takes to reduce its negative impact on the environment. The team comprehensively informs all interested parties about environmental issues related to its activities. In addition, it should be noted that the objectivity and accuracy of the report is confirmed by the verifier. If this communication tool is used to the fullest extent and is available to really all stakeholders, it can often positively change the view of professionals and the general public on an organization that has so far been perceived from an environmental point of view, based only on various partial and mediated information often produced by different interest groups. By selecting the most important indicators, the company can inform all stakeholders in an appropriate way how it strives to continuously improve the company's environmental behavior and thus ensure the improvement of the brand's image and reputation.

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Hierarchical clustering of EU countries based on HDI and EPI index

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Abstract.

The aim of this paper is to evaluate the global competitiveness regarding the environmental economics model, considering all three levels: economic, social, and environmental. We measure the socio-economic dimension using HDI (Human Development Index) according to the health and education areas, then we measure the environmental dimension using EPI (Environmental Performance Index), which monitors the behaviour of countries in the field of human health protection and ecosystem protection. This paper focuses on the possibility to group countries by the cluster method in terms of assessing the sustainable competitiveness of European countries. The question is whether there is an appropriate classification for the development of these countries that could help to reduce the differences between the average countries and the EU 27 average. The approach to this topic began with the question whether these countries, which have high values of economic growth, have a high level of EPI or HDI. The intention is to look for the possible existence of a gradual rapprochement of countries belonging to the same group.

Keywords: cluster analysis, HDI index, EPI index

JEL classification: C 38, P 28, Q 56

1 Introduction

The aim of this paper is to evaluate the global competitiveness regarding the environmental economics model, considering all three levels: economic, social, and environmental. We measure the socio-economic dimension using HDI according to the health and education areas, then we measure the environmental dimension using EPI, which monitors the behaviour of countries in the field of human health protection and

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ecosystem protection. This paper focuses on the possibility to group countries by the cluster method in terms of assessing the sustainable competitiveness of European countries, especially Slovakia and the Netherlands. The question is whether there is an appropriate classification for the development of these countries that could help to reduce the differences between the average countries and the EU 27 average. The approach to this topic began with the question whether these countries, which have high values of economic growth, have a high level of EPI or HDI. The intention is to look for the possible existence of a gradual rapprochement of countries belonging to the same group.

In 1939, Robert Choate Tryon first used the term from noise analysis [1]. Cluster analysis is a classification procedure that groups objects into distinct subgroups that are similar within but different than objects included in other subgroups. The resulting branching diagram is a classification that provides a sequence of clusters (subgroups) according to which a group of objects is divided. For instance, if several ecological units are examined, this analysis is suitable for showing species composition patterns between these units. Cluster analysis essentially creates a dendrogram or tree, the branches of which represent each of the ecological units, and the data on the species composition of these places determine the structure of the branch. Merged branches represent groups or clusters of sites with a similar species composition and the length of a branch before merging is inversely proportional to the degree of similarity of the species composition.

There is a wide range of cluster analyses, we focused on hierarchical, agglomerative, where each object is considered a cluster. The choice of an appropriate method is crucial because it determines (partially) a classification derived from species composition data. Like many multidimensional statistical analyses, cluster analysis attempts to represent complex relationships between objects, in our case between countries, in a simple one-dimensional way. We processed the application of cluster analysis using a comparison of 3 classifications on a set of 15 EU countries. The status of all acquired variables reflects the observed period of the most recently obtained data at the end of 2018, which represents the full coverage of the variables HDI (Human Development Index) and EPI (Environmental Performance Index) for all monitored countries.

2 Methods and methodology

Cluster analysis of a multidimensional data set aims to divide a large set of data into meaningful subgroups of subjects. In cluster analysis, many methods are available to classify objects based on their (un) similarity [2]. Dasgupta [3] framed similarity-based hierarchical clustering as a combinatorial optimization problem, where a “good” hierarchical clustering is one that minimizes a particular cost function. Murlag and Contreas [4] made a survey of agglomerative hierarchical clustering algorithms and discussed efficient implementations that are available in R and other software environments. They look at hierarchical self-organizing maps, and mixture classifications reviewed grid-based clustering, focusing on hierarchical density-based

approaches. Jafarzadegan at all proposes a novel method of combining hierarchical clustering approaches based on principle component analysis (PCA). PCA as an aggregator allows considering all elements of the descriptor matrices. In their approach, basic clusters were made and transformed to descriptor matrices. Then, a final matrix was extracted from the descriptor matrices using PCA and dendrogram were constructed from the matrix that was used to summarize the results of the diverse clustering [5].

We expand the data matrix X of pxk type with p objects and k indicators into the set C by means of clustering procedures with all clusters m , where the objects of the primary matrix X were grouped. The total number of clusters m has the possibility to range from 1 to p , while the best situation occurs when we reach the number of clusters smaller than the number of objects (in our case the studied countries) [6].

From the most well-known metrics of distances between objects, we chose the *Euclidean distance of objects* for our analysis, which is set by the following equation [6]:

$$d(X_i, X_j) = \sqrt{\sum_{s=1}^k (x_{is} - x_{js})^2} \quad (1)$$

Where:

x_{is} is the value of the s -th variable for the i -th object.

x_{js} is the value of the s -th variable for the j -th object.

This distance measurement, which generalises the concept of physical distance in two- or three-dimensional space to multidimensional space, is often referred to as the "Pythagorean distance" and forms the basis for Ward's method.

The main types of analysis are hierarchical clustering procedures, which are divided into:

- **agglomerative** - the decomposition process begins with each cluster that contains exactly one object and continues the decomposition by a suitably selected method until all of them are merged into one cluster;
- **divisive** - the opposite procedure begins with one cluster containing all objects and gradually splits into smaller clusters [7].

Next, we will deal with hierarchical clustering procedures, where there are several different methods used to determine which clusters should be combined at each stage, *Nearest-neighbour clustering method*, *Median method* and *Ward's method* were chosen to collect minimised heterogeneity clusters.

The median method is described by the following two equations [7]

1. Nearest-neighbour clustering method ("*Nearest*")²

² The nearest neighbour method uses the distance of the nearest cluster elements C_h and C_r

$$D_1(C_h, C_r) = \min \{d(X_i, X_j)\}$$

$$X_i \in C_h, X_j \in C_r \quad (2)$$

2. Median method ("Median")³

$$D_2(C_h, C_r) = d(\bar{X}_h, \bar{X}_r) \quad \text{where} \quad \bar{X}_h = \frac{1}{n_h} \sum_{X_i \in C_h} X_i, \quad \bar{X}_r = \frac{1}{n_r} \sum_{X_j \in C_r} X_j \quad (3)$$

Ward's method is a correct hierarchical procedure and makes it possible to determine how many groupings should be considered, and its great advantage is the tendency to remove small clusters and form clusters of roughly the same size. The similarity between 2 clusters is the sum of the squares in the clusters summarised in all variables, the proximity between the 2 clusters being defined as the increase in the square root error resulting from the merging of 2 clusters [8]. In the case of the Ward's method in terms of distance, equation 4 can be formulated in the form of the product of the Euclidean distance of objects between the centre of clusters conditioned to join and the coefficient, based on the size of the cluster⁴ [9]:

$$D(C_h, C_r) = \frac{n_h n_r}{n_h + n_r} \times d^2(\bar{X}_h, \bar{X}_r) \quad (4)$$

The results of hierarchical clustering can be displayed graphically using a tree diagram - "dendrogram", which shows all the steps in a hierarchical process, including distances, where clusters combine.

3 International Sustainability Indices

In this part of the paper, we come to specific variables, sustainability indices. In the case of the HDI index, we used 3 main dimensions and related indicators within the EU countries. We proceeded in a similar way in the case of the EPI index, where we evaluated countries in 24 performance indicators in ten categories of problems related to Environmental Health and Ecosystem Vitality.

³ The Median clustering method uses the distance between the centroids of the clusters and serves as an improvement to *the Centroid method*

⁴ In hierarchical grouping, the sum of squares starts from zero (each point is in its own grouping) and then increases as we merge the clusters. Ward's method keeps this growth as small as possible. Considering two pairs of clusters whose centres are equidistant from each other, the method prefers to merge the smaller ones.

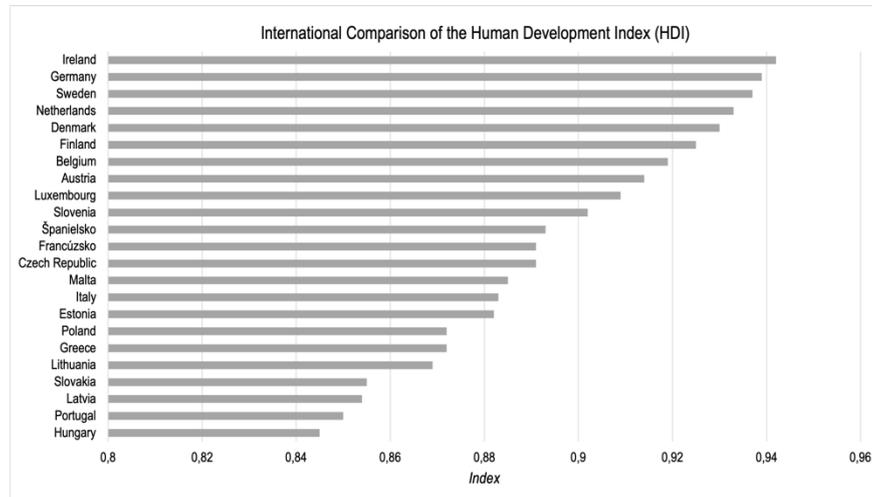


Fig. 1. International Comparison of the Human Development Index (HDI) ⁵

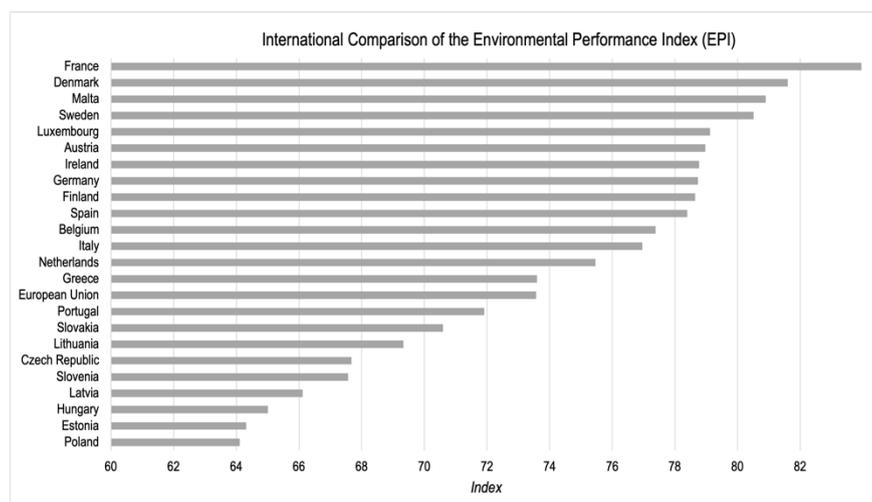


Fig. 2. International Comparison of the Environmental Performance Index ⁶

⁵ Source: Own processing according to UNDP (United Nations Development Programme: Human Development Index (HDI). Dimension: Composite indices.

⁶ Source: Own processing according to Yale Center for Environmental Law & Policy. Center for International Earth Science Information Network. Earth Institute. Columbia University. 2020.

4 Hierarchical clustering procedures

The last presented analysis is a comparison of 3 classifications of cluster analysis on a set of 15 countries of the European Union. Our 2 examined variables were: Human Development Index (HDI) and Environmental Performance Index (EPI) as aggregated indicators, which we described in more detail in the introduction in the first chapter, from a methodological point of view in the third chapter and their application in the last chapter Results.

The characteristics of the raw data was considered in the selection of appropriate hierarchical clustering procedures. In the cluster analysis of our data, we used the statistical software SAS Enterprise Guide 4.2⁷, which forms hierarchical clusters of observations containing the coordinates of the data, but also their distances. If the data set contains coordinates, the cluster analysis calculates the Euclidean distance of the objects before the clustering method is applied. The result of hierarchical agglomerative clustering is a graph displayed as a tree diagram - a "dendrogram", which can be displayed in the SAS system in 2 ways, vertically or horizontally. The main use of the dendrogram is to find the best way to assign objects to clusters, and the key to interpretation is to focus on the height at which the two different objects are connected.

4.1 Nearest Neighbor Method

To compare the first cluster analysis classification, we used the *Nearest Neighbour Method* as the first of the hierarchical clustering methods. The principle of the nearest neighbour method is that the algorithm uses a minimum distance to measure the distance between clusters and 2 objects placed in a cluster are separated from each other by the shortest possible distance, gradually adding more clusters to the original objects by creating the 3rd nearest neighbour. After processing the classification using SAS, we constructed a dendrogram.

Table 1. Clusters according to the nearest neighbour method⁸

CLUSTERS	EU COUNTRIES
1.	Sweden
2.	Hungary, Slovakia, Greece, Italy, Netherlands, Belgium, Luxembourg, Austria, Czech Republic, Finland, Germany, Ireland, France, Denmark

⁷ Available on the SAS software website:

<https://www.sas.com/sk_sk/trials/software/covid19/form.htm>

⁸ Source: Own processing according to data obtained from HDI and EPI index variables

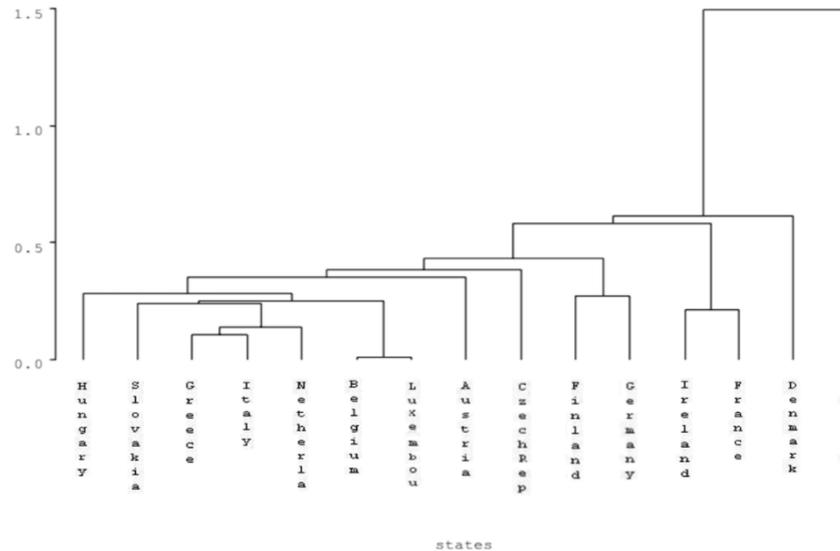


Fig. 3. Cluster created according to the nearest neighbour method⁹

According to the constructed dendrogram (Fig. 2) and from table 1 it follows visually and analytically that we divided the set of 15 countries into 2 clusters. If we take a closer look at the formed clusters, we can state that cluster 2, as a larger group, contains the predominance of 14 developed countries of the European Union. Countries such as Denmark, France, the Netherlands, Italy, Greece, Slovakia, and Hungary used the dendrogram to show a similar level of HDI and EPI indices. Cluster 1 is made up of only one EU country, Sweden, as significantly more advanced in terms of obtaining higher values of HDI and EPI indices.

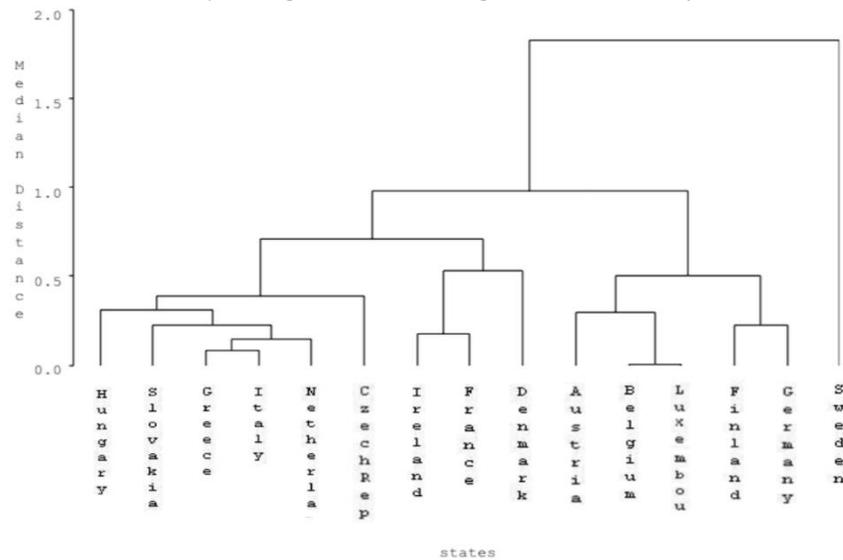
4.2 Median Method

As the second method of cluster analysis for the comparison of European countries, we chose *the Median method*, which serves as a certain upgrade of the *Centroid method*. We have described the detailed principle of these methods in more detail in the previous chapters. The centroid method uses the distance between the centre of gravity of two clusters to evaluate the overall solution of the cluster, with the centre of gravity representing the centroid of a particular cluster. The distance between two clusters is calculated as the difference between the centres of gravity. The median method is based on the median, which follows from the name itself, and instead of calculating the average for each cluster to determine its centre of gravity, it calculates the mean distance between all pairs of observations or individuals in the clusters. After the data for this classification were processed, we built a dendrogram using SAS software.

⁹ Source: Own processing according to data obtained from HDI and EPI index variables

Table 2. Clusters according to the median method¹⁰

CLUSTERS	EU COUNTRIES
1.	Sweden
2.	Hungary, Slovakia, Greece, Italy, Netherlands, Czech Republic, Ireland, France, Denmark, Austria, Belgium, Luxembourg, Finland, Germany

**Fig. 4.** Cluster according to the median method¹¹

According to Table 2 and the dendrogram (Figure 3), we can observe a very similar situation as with the nearest neighbour method. We redistributed 15 countries into 2 main clusters. Cluster 2 contains again a set of 14 EU countries, whose monitored data of HDI and EPI indices are relatively similar. While Sweden belongs again to the 1st cluster and shows its strength over other countries, especially within the HDI and particularly in the dimension index called the "*Education index*".

4.3 Ward's Method

As a final analysis, we present the most used method in marketing called *the Ward's Minimum Variance method*. Ward's method creates clusters that minimise variance in each cluster. For each cluster, the average for each variable is calculated and, in each cluster, the observations are compared to the average for each variable. The observations or clusters are combined in a way that the variance in the resulting cluster

¹⁰ Source: Own processing according to data obtained from HDI and EPI index variables

¹¹ Source: Own processing according to data obtained from HDI and EPI index variables

of solutions is minimised as much as possible. Following the summary of the data of our analysis, we prepared a table and constructed a dendrogram using SAS software.

Table 3. Clusters according to the Ward's Minimum Variance method¹²

CLUSTERS	EU COUNTRIES
1.	Hungary, Slovakia, Czech Republic, Greece, Italy, the Netherlands, Austria, Belgium, Luxembourg, Finland, Germany
2.	Ireland, France, Denmark, Sweden

The illustrated dendrogram (Figure 4) illustrates the situation of 2 constructed clusters of countries, which can be very nicely distinguished from the cluster formed by Ward's Minimum Variance method. On the right side of the dendrogram we see cluster 2, which connects the 4 strongest countries in northern Europe. They are the world's richest economies with even income distribution, low unemployment, and highly developed institutionalisation, in terms of human data development index (HDI) and environmental performance index (EPI), what evokes a high level of standard in countries. From the opposite left side of the dendrogram, we can observe developed countries connected by one cluster with relatively similar values of the HDI and EPI indices. Although more significant differences can be seen mainly in countries such as Hungary (left side of the dendrogram) and Germany (closer to the Nordic countries of the dendrogram), where the differences are obvious and Hungary is trying to catch up, but it is not enough yet. Table 3 also clearly shows 2 clusters with a division of countries according to the achieved values of HDI and EPI indices.

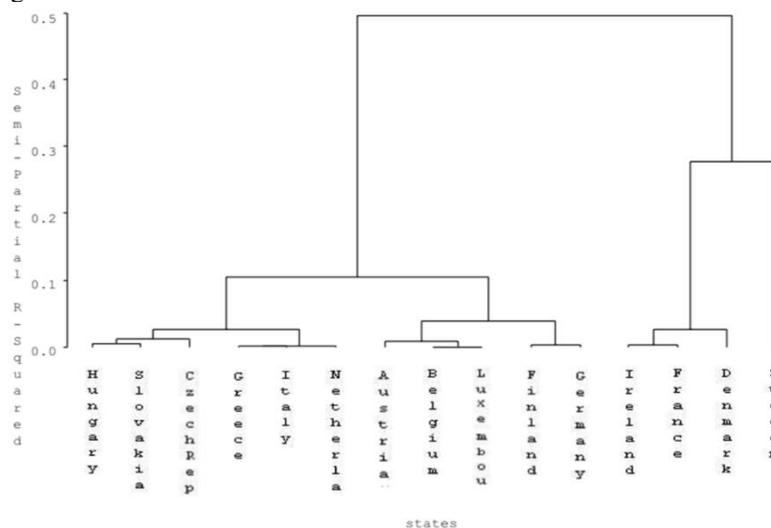


Fig. 5. Cluster according to the Ward's Minimum Variance method¹³

¹² Source: Own processing according to data obtained from HDI and EPI index variables

¹³ Source: Own processing according to data obtained from HDI and EPI index variables

When it comes to cluster properties, it is important to look at the values that countries indicate for the two indicators used for the analysis. In the case of cluster 1, things are clear: we have an economically strong country that seem to be operating under the control of the objectives of the European strategy and the appropriate values for an important environmental factor. In the case of clusters of the 2nd degree, we can observe interesting situations with all 3 analysed methods. In the case of Slovakia, we can see in the first nearest neighbour method how it reworked for the 2nd lowest position, which analyses that of all the countries studied, together with Hungary and Greece, it has the highest average of HDI and EPI indices. On the other hand, the Netherlands is approaching the average values of the indices to Belgium and Luxembourg. As defining features for the country in this grouping, we can say that they have an average employment rate between 70% and 81.1% (except Greece - 64% and Poland 64.60%) as well as high values for greenhouse gas emissions above 102 compared to 1990. These countries are the ones that need to make sustainable efforts to become knowledge-based economies. In the analysis of the median method, we get similar results as in the case of the first method, but the fundamental difference is the distance used between the centre of gravity of the two clusters to evaluate the overall solution of the cluster. However, it is more interesting in the last Ward's method, where the strongest EU countries (Sweden, Denmark, France, and Ireland) separated into a second cluster. The countries in cluster 1 seem to have interesting characteristics: greenhouse gas emissions are less than 71, compared to 1990 at 100, except for Belgium (92) and Sweden (91), and compared to cluster 2, the countries have a higher average of people at risk of poverty and lower average of primary consumption.

Cluster analysis is an important tool for any study to identify possible intentions for convergence in living standards, education, GDP growth, life expectancy and environmental protection to measure overall progress in environmental sustainability.

One of Britain's professors of environmental economics, Paul Ekins, suggested in 2011 that there was a link between environmental performance and measures to improve environmental sustainability. Ideally, these measures would include [10]:

- 1) development of better measurement and monitoring systems to improve the collection of environmental data, the so-called environmental data;
- 2) development of environmental policies focused on extremely weak areas;
- 3) communication of data and statistics at national level to international agencies such as the United Nations (UN);
- 4) the definition of sub-national metrics and targets for the improvement of environmental performance.

5 Conclusion

In this paper we made a comparison of 3 classifications of cluster analysis on a set of 15 EU countries using 2 examined variables of human development and environmental performance indices as aggregate indicators. During our

multidimensional statistical classification, clusters were designed based on the HDI, EPI indices to evaluate the sustainable performance of EU members, as well as possible convergences between them at EU Member State level. The indicators used in the analysis form different groupings and most of the overlapping occurs in the groupings whose countries came first. This type of behaviour is typical of countries with strong economies, which record performance at all three socio-economic and environmental levels and pursue consistent development policies. Sweden and Denmark are the countries that appear in the first grouping in all analysed cases. Among the EU countries, Sweden appears most often in the leading grouping in all 3 analysed cases. The Czech Republic and Slovakia are ranked the best among the former communist countries and Luxembourg, Belgium, and the Netherlands as the third among the "Benelux" countries.

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Environmental aspect of investment in solar system in example of business providing public services. Case from Slovak Republic

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Abstract: This paper focus on environmental investment made in small firm in solar system. Based on literature review and recently introduced financial mechanism of European Union for membership states to recover and help countries to become more efficient, digitalized, and face climate changes after COVID-19 crisis, it becomes crucial to point out that not all “green solutions” might yield sustainable advantages. Case from Slovak Republic shows that investment in solar system made in 2017 is dropping its competitive advantage when we calculate Life Cycle Assessment. Paper is dealing with national policies declared by state authorities in Slovak Republic and also European Union with tendency to lower emissions of CO₂. When assuming that goals of state authorities and EU are reachable in field of energetic mix, in this particular case the firm will be leaving higher carbon footprint 10 years after investment in solar panels as it did not invest in solar system. In 2017, the savings in the carbon footprint of the surveyed company in LCA in absolute terms amounted to 1551 tons, or 0.03 tons per kWh, but by assumptions, in 2027 carbon footprint will be higher by 0,005 ton per kWh despite operating own solar system.

Keywords: Renewable Resources, Life Cycle Assessment, Carbon Footprint

JEL classification: *Q20, Q42, Q40*

1 Introduction

This paper uses case study of small business operating solar system while providing services. Primary research objective of this paper is to illustrate environmental aspect of investment, particularly the change in carbon footprint of examined business and how it varies depending on the national primary energy mix when compared to year the

solar system. In addition to primary objective there are supportive objectives to enumerate direct emissions of firms depending on its activities and carbon footprint.

Study also deals with plans of Slovak Republic to achieve specific targets to decrease carbon footprint, how the primary energy mix should be transformed according to National “Recovery Plan”. According to official international and national documents, as its later referred on, there is a plan to change primary energy mix of Slovak Republic in favor of renewable resources. Use of the simple Life-cycle assessment might provide a better look at planned massive investments towards national primary energy mix of Slovak Republic and its environmental aspects.

The whole world recently experienced and is still experiencing repercussions and challenges in regard to COVID-19 pandemic. Spread of the global pandemic threw a bit of oblivion on environmental crisis the world is also dealing with. Extreme changes of the weather are giving foretaste, that after facing COVID-19 challenges humanity might be entering another possible crisis - at the climate level.

2 Literature review

Carbon dioxide (CO₂) is the primary cause and driver of global warming, according to several recent studies. (Xu et al., 2021; Xiao-Ming et al., 2021) The phenomenon of global warming refers to the continual rise in the temperature of the planet's oceans, atmosphere, and land. (Tuel – Eltahir, 2020) Carbon footprint (CF) is a new measure of sustainability as it is able to determine the overall impact of society activities on climate change (Delre et al., 2019) and as a consequence of global actions done to slow down impacts on the environment while maintaining increasing production, the focus of discussion has recently turned to the CF minimization. (Ødegaard, 2016; Xu et al., 2017) CF is defined as “the total amount of carbon dioxide emissions, directly and indirectly, caused by an activity or that accumulated over a product lifetime”. (Lombardi et al., 2017) As described in study of Maktabifard et al. (2020) aiming at the energy neutrality is reasonable in terms of the CF provided that the total CF is not increased.

As reported by British Petroleum Company (2020) the biggest global CO₂ contributors are China, United States, European Union, India, and Russia. European Union (EU) introduced and approved financial aid to member states in total allocation of EUR 806,9 bn. in years 2021 – 2027 as NextGenerationEU. This unprecedented and highest financial help to member states should help national economies to recover after COVID-19 with emphasis on digitalization, transformation to sustainable production, but more importantly, 30% of the budget is intended to be used for engagement with climate crisis and its consequences, what represents EUR 242 bn. As recent research suggests that investment into climate-friendly policy initiatives may help the world move closer to a net-zero emissions pathway, as targeted in the 2020 European Green Deal. (European Commission, 2019; European Commission, 2021)

All activities financially supported by EU to decrease CF, to meet net-zero emissions are reflected at National levels of individual member states. As concluded in study by Mekonnen et al. (2016) energy scenarios are mainly developed based on forecasts of

future energy demand and on expectations regarding the swiftness with which humanity will shift away from fossil fuels to renewable energy.

Slovak Republic as member of EU elaborated and approved Recovery Plan, which is covenanted to fulfill NextGenerationEU goals in years 2021 – 2027. As stated in chapters 1.4.2 and 1.6.2 of Slovak National Recovery Plan (2021) investments tend to support the construction of new renewable energy capacities and the modernization of existing ones with goal producing electricity from renewable resources in the total volume of 220 MW of installed capacity as contribution to the reduction carbon intensity of energy and support the achievement of the EU target.

Recent findings of EU Joint Research Center (JRC) (2021) says although nuclear as a source of energy produces very low greenhouse gas emissions, the management of nuclear waste raises doubts about sustainability. Slovak ministry of Economy also stated in energetic and climatic documents (2019) to avoid using coal as energetic resource and gradually abandon from non-liquid fossil fuels as coal.

In accordance with mentioned investments there should be also considered Life Cycle Assessment (LCA), a well-established methodology for assessing the energy and environmental performances associated with all stages of a system's life cycle regulated by the international standards of ISO. (Beccali et al., 2016) However, the LCA method provides a limited basis for evaluating future technology improvements and changes in economic and energy structure as it only reflects current or historical realities. (Huang and Eckelman, 2020; Chen et al., 2021). It is important to bear in mind, that LCA does not consider changes in technology in its analysis – all the results of LCA are based on the indicators and values set in the past. According to several authors, the term 'life cycle' refers to supply chains of products and does not consider consumption patterns. Most studies use a product as a research object, in form of a good, service, or product service system. (Bieser and Hilty, 2018; Pohl et al., 2019)

In case of LCA, the first step in doing a LCA is collecting data on the environmental impact of the different processes involved, from extracting raw materials to transforming them in a factory (Campoy, 2009). As mentioned by Zink-Geyer (2016) LCA results in a set of environmental impact indicators per product or service. As stated by Joint Research Center (2021) when selecting between two or more choices, decision makers may use LCA to compare and choose the product or method that has the least impact on the environment and human health. It gives a comprehensive picture of environmental consequences across all phases of the life cycle, identifying hotspots that may be improved in the process to meet environmental goals. As defined by Suski et al. (2020) consumption is defined as an economic transaction that results in market activity in the articles of consequential LCA. Discussions and advances in the field of LCA on the consequential approach are key contributions. Consumption reduced to the act of buying, on the other hand, is shallow when contrasted to a holistic, integrated approach to assessing sustainable consumption. According to the European Commission's Better Regulation Toolbox (2015), LCA is well adapted to offer complete, integrated environmental evaluations that aid in the establishment of national and international regulations.

The development of a complete LCA (including manufacturing, operation, and end-of-life) for complex systems can be a time and human resources intensive exercise.

(Beccali et al., 2016) For this reason, to have simplified and quick calculation tools for assessing the energy and environmental aspects of energy resource during their life cycle seems useful to support researchers, designer and decisionmaker to understand advantages and disadvantages. As described by Suski et al. (2020) The development of LCA might be considered an easy task in one regard - It always aligns with other disciplines and methods, such as mechanical engineering to describe material and energy flows in the production system or economics in the case of consequential LCA. Therefore, to develop LCA to raise questions of consumption, reviewing concepts in other disciplines is commonly used methodological approach.

3 Methodology

This part of paper describes methodology of research, it summarizes methodological framework, objectives, used methods, data sources, and pre-defined assumptions.

Assessments based on energy modeling usually fail to consider the environmental profiles of energy systems as they mainly focus on energy use and direct emissions. (Chang et al., 2017) Although energy models may include some environmental aspects through emission factors. Soft- and hard-linking approaches are used to hybridize models. (Huang and Eckelman, 2020) In soft linking approaches, the results are transferred from one model to another, while in hard-linking approaches, the models are integrated into one comprehensive model. In this case study the hard-linking approach was used. In this paper is used a general methodological framework for LCA according to ISO 14040 as illustrated in figure 1 below.

Primary objective of this study is to describe environmental aspects of an investment in case study, particularly how CF of firm's activities varies in relation to changing national primary energy mix.

Computation of direct emissions – emissions produced by energy consumption – its secondary objective of this paper, as well as change in tariff charged for energy consumption in relation to primary energy mix.

The very first step was review of existing literature - the search, organization and selection of papers published in well-known databases, such as Web of Science and Scopus. Search in databases was realized with main keywords and their mutual combination: life-cycle assessment (and its variations), carbon footprint, solar system.

Methods used in this paper: The LCA is a relative method that is structured by the functional unit, according to the requirements of EN ISO 14040 and EN ISO 14044. The functional unit used in this paper is 1 kWh net energy provided to the grid, respectively the electricity power obtained through solar system in case study. Auxiliary power is factored into the efficiency and hence subtracted ahead of time. Because all environmental consequences are represented in terms of kWh, they may be compared to other research. Beside LCA is in this paper also used observation, analysis, synthesis, and benchmarking.

After defining the assumptions regarding the median values for individual primary energy sources, the LCA coefficient was calculated, similarly as in study of Mekkonen et al. (2016):

$$LCA_{coef,total} = \sum_s (E \times EM[s] \times LCA [s])$$

where E stands for the electricity production (kWh), EM[s] the relative contribution of energy source s in the primary energy mix in Slovak Republic (%), and LCA [s] is the median value of emissions per source used in life cycle of electricity produced from energy source s (kg/kWh). LCA is related to the three major stages of the supply chain: fuel supply, construction, and operation and therefore it provides useful information how CF varies in “the whole picture”.

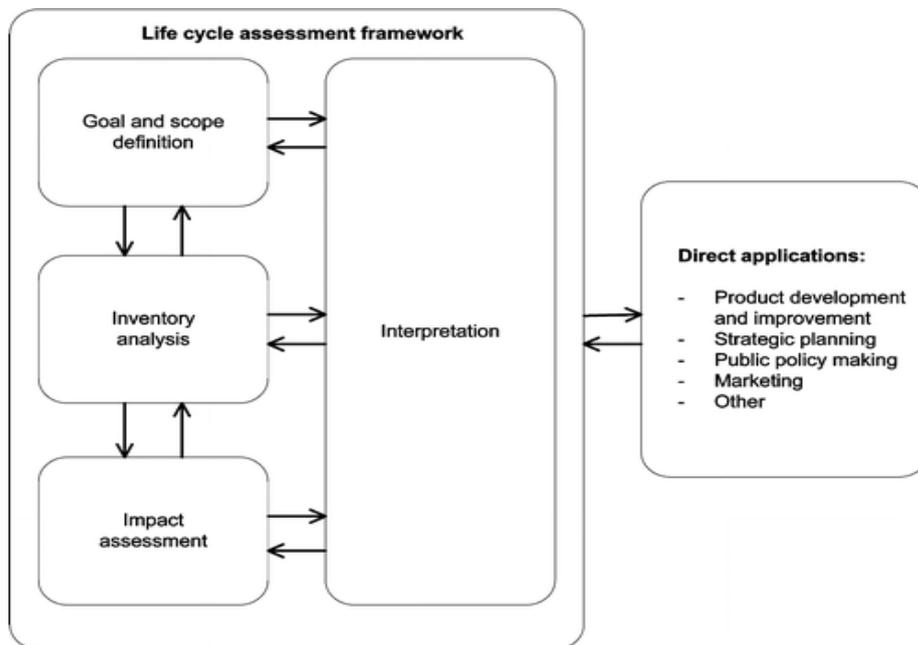


Fig. 5 General methodological framework of LCA. (EN ISO 14040, 2006)

LCA method could be carried out in different ways: attributional, consequential, and hybrid. (Guinée et al., 2018) This paper approach is based on hybrid model of LCA, however it deals with attributes of emissions depending of set factors and consequences in form of CF.

To approximate benchmark level to compare CF in case study using solar system while fixed energy consumption, study uses data of Slovak Powerplants from years 2017 and 2020. Year 2017 was chosen as starting point in analysis. Year 2020 as the most recent according to reachable data, to benchmark CF in relation with changes in primary energy mix. Year 2027 is containing targeted values by Slovak Republic and EU.

Data mining for this research was done from various sources:

- case study of small firm operating own solar system provides useful information about the capacity of energy that firm is able to produce by itself;

- websites of Slovak National Powerplants, Statistical Office of Slovak Republic, Recovery plan of Slovak Republic: used for the comparison of primary energy mix in time series and planned change in an energetic infrastructure;
- publication of European Central Bank (ECB) for predicted inflation in energetic sector: ECB staff macroeconomic projections for the euro area. (ECB, 2021)
- existing literature used to compute: LCA, CF difference, and median values of emissions produced per energy source. (Hunt, 2001; Ármannsson, 2003; Parliamentary Office of Science and Technology, 2006)

As stated in several methodological chapters of studies, LCA practitioner or researcher needs to find reasonable assumptions to carry out LCA analysis. (Suski et al., 2020; Guinée et al., 2018)

Pre-defined assumptions this study considered:

- for computing emissions is used composition of primary energy mix for year 2017 as a starting point and data for year 2020 as the most recent. For year 2027 is used relative share of energy resources according to mentioned official National documents to meet target of NextGenerationEU;
- as there is no specification which renewable resources will be targeted primary, the share will be divided proportionally among renewable resources according to actual values;
- consumption of kWh contained in this paper will arise from case study data of year 2019. Year 2019 is better to illustrate energy heftiness and requirements, as in years 2020 and 2021 were data strongly influenced by COVID-19 restrictions and closed facility due to lockdowns;
- to simplify analysis, study assumes all factors *ceteris paribus* and deals with changes in primary energy mix of Slovak Republic.

4 Results

In this part of paper is continually described how analysis of LCA of selected case study was approached. According to case study data it is possible to illustrate how much energy was self-produced. Self-efficiency is expressed as a difference between energy production and consumption is illustrated in figure 2 below. Green line represents the amount of kWh the firm was able to produce, and orange columns shows actual energy consumption for given month, marked from 1 to 12, as 1 stands for January, etc. Obviously in months with more sun light there is bigger production. It is observable that in given geographical location there is sharper decline in production of energy in autumn period in September in contrast to August than is continual growth from March until June.

Table 1 illustrates aggregate data from case study. Beside total production and consumption in given years there is also average value of tariff firm was charged. Vale of tariff is given as average per calendar year, as there are discrepancies in tariffs during

the year according to season. Values from year 2019 of case study are used as fixed for all computations because of reasons mentioned in pre-defined assumptions. For year 2021 data are incomplete, covering only half of a year.

Table 22 Aggregate data from case study. Source: Authors processing.

	2017	2018	2019	2020	2021*
consumption (kWh)	41305	41826	40925	12220	7850
production (kWh)	6837	10515	10592	4170	3985
difference (kWh)	34468	31311	30333	8050	3865
tariff per unit – average (€)	0,0710	0,0790	0,0808	0,0988	0,0930

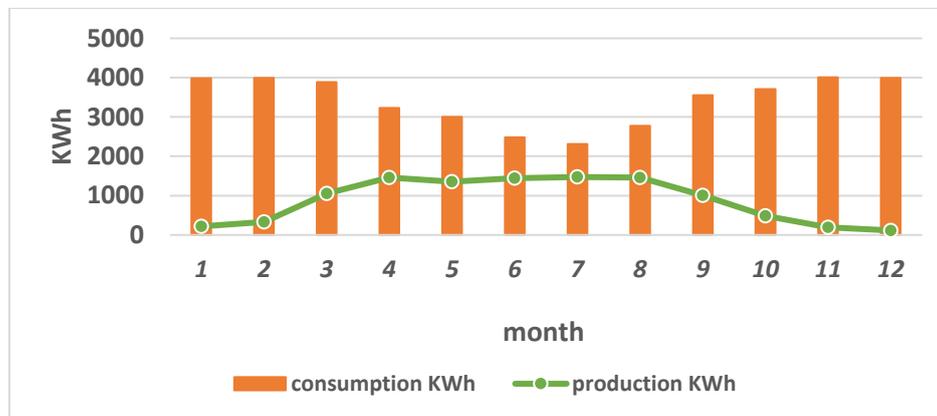


Fig. 6 Energy self-efficiency of case study after solar system installation. Source: Authors processing.

Table 2 contains data about quantity of CO₂ emissions according to source used for energy consumption. There is also stated the median value of emissions which varies depending on primary energy source of power plant. Table 2 shows how primary energy mix (PEM) of Slovak Republic has changed in the observed time period. According to data of Slovak Powerplants and Statistics Office of Slovak Republic, in 2020 powerplants generated 18,773 GWh of electricity in total. Net electricity delivery of Slovak Powerplants in 2020 in total was at 16,994 GWh. As much as 95 % of electricity delivered was generated without direct carbon dioxide emissions – combining nuclear, hydroelectric, photovoltaic and biomass.

In comparison with year 2017 resources has changed according to powerplants annual records as described in table 2. There was decrease in share of coal in PEM, what leads to decreasing CF caused by energy production, as the coal is the most burdening fuel for energy production in the whole life-cycle point of view. As seen in table 2, the nuclear powerplants increased their share in PEM from approximately 52% to 83,5%. As mentioned earlier, nuclear energy is the purest one from the ways

humanity obtains energy, but there are still many different opinions when discussion come to liquidation of nuclear waste.

Table 23 CO2 emissions per energy source, median value of CO2 in life cycle, relative share of energy sources in PEM of Slovak Republic. Source: Authors processing according to (Ármansson, 2003; Hunt, 2001, Parliamentary Office of Science and Technology, 2006; Slovak powerplants, 2021; Statistics Office of Slovak Republic, 2021; Recovery Plan, 2021)

	g CO2 per kWh – source	kg CO2 per kWh – median of life cycle	share in PEM of SR 2017	share in PEM of SR 2020	targeted share in PEM of SR 2027
gas	0,5	622	0,07	-	-
oil	0,65	NA	-	-	-
coal	0,9	1041	0,12	0,05	-
nuclear	0,005	17	0,52	0,835	0,85
solar	0,058	39	0,007	0,001	0,005
biomass	0,0	46	0,05	0,01	0,025
water - pumped	0,02	18	0,13	0,09	0,1
water	0,005	18	0,04	0,02	0,02
wind	0,005	14	-	-	-

Values in table 2 show the amount of CO2 emissions and CF according to used energy resource, during to whole life cycle – from extracting to generating power. Values were used to identify, if there is not large deviation from median values, same as referred in EN ISO 14044: Environmental management - Life cycle assessment - Requirements and guidelines. Table 3 contains values of computed LCA coefficient according to case study data and data in previous tables 1 and 2. In table 4 is stated how differs CF of case study.

Table 24 Values of LCA determined by energetic mix in Slovak Republic and its relative share

Source of energy	Relative share	LCA coefficient
	2017	
gas	0,07	622
biomass	0,05	46
nuclear	0,52	17
water	0,17	18
coal	0,12	1041
solar	0,007	39
	2019	
biomass	0,01	46

nuclear	0,835	17
water	0,11	18
coal	0,05	1041
solar	0,001	39
	2027*	
biomass	0,025	46
nuclear	0,85	17
water	0,12	18
solar	0,005	39

Table 25 Production of CO2 by firms' activities with fixed consumption and production of solar energy by firms' solar system

Year	Production CO2 with solar system	Production CO2 without solar system	difference
2017	6036 tons	7587 tons	1551 tons
2019	2508 tons	2826 tons	318 tons
2027 (predicted)	958 tons	735 tons	-223 tons

As seen in table 3, LCA coefficient is changing as is changing PEM of Slovak Republic. Assumed on results, CF in case study has decreased. Thus, it is possible to conclude, that investment in solar system has also met the conditions of environmental aspects, beside the economical. Only two years after investment in solar system, the investment in solar system is losing its environmental advantage as it is possible to see in table 4.

Significant difference of case study is seen between years 2017 and 2019, as illustrated in table 4. For the same amount of energy was the whole LCA decreased from 7587 tons to 2826 tons in total. In relative deliverance, in 2017 Slovak Republic emitted 0,18 tons of CO2 per kWh during life cycle, while in 2019 it was only 0,07 tons of CO2 per kWh.

5 Conclusions

As a result of this paper, it is possible to state, that investing in solar system in this case study can bring the desired results if we look at the problem through LCA analysis - the carbon footprint has been reduced, the burden on the environment has decreased when expressed through the amount of CO2 emissions. Case study showed that change in structure of PEM of Slovak Republic has changed the environmental advantage of solar system. Mentioned result is consequence of gradual withdrawal from the use of coal as the primary energy source in the PEM, and its replacing with nuclear energy and

renewable resources. In the other words, solutions that bring benefits 2 years ago are starting to lose their advantage in very short time.

This particular case study showed that transition to renewable resources is bringing along a question of increasing energetics tariffs and payments. Investing in new infrastructure, technologies, and ways of producing power might lead to increase of price.

As this paper was following pred-defined assumptions: fixed energy production of firm solar system, as well as the fixed energy consumption as in the default year 2019; all the covenants intervening from European Union (European Commission), National authorities will be fulfilled according to Recovery plan of Slovak Republic and NextGenerationEU to obtain financial resources; then from the environmental aspect the carbon footprint of this case study might be significantly higher just ten years after investment, nevertheless solar panels should be one of renewable resources that help to reduce environmental load of human activities.

If all the assumptions of this paper are fulfilled, then there might be situation, that environmental solution might after few years come to state, when it will not be serving its purpose, by contraries it may lead to bigger environmental and ecological burden.

From presented paper it may be obvious, that biggest change in PEM was mainly by increasing the share of nuclear power. Question for future research might be in place if humanity has sustainable plan to operate with nuclear waste.

Presented case should be helpful warning for public discussion with policy makers, as well as the politicians, as not every solution at first glance, an ecological solution can meet the parameters even in the time horizon of five or ten years. The basis not only for National Authorities or European Union, but for whole world should be the environmental approach, but also its sustainability. The reason is that the current problem does not move half a generation later, when resources, whether material, financial or human, may not be available.

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Speculative Measurement in Business Combinations

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Abstract. The process of business combinations is closely linked to measurement. International Financial Reporting Standard IFRS 3 Business Combinations contains a large part focused on measurement. Measurement in business combinations can be divided into three areas, which are the measurement of the acquiree's identifiable assets acquired and liabilities assumed, the measurement of non-controlling interests and the measurement of goodwill or gain from a bargain purchase. The measurement of the acquiree's identifiable assets acquired and liabilities assumed is associated with the measurement principle, which states of fair value measurement. In the case of measurement of non-controlling interests, there are two measurement options - fair value measurement and proportionate share measurement. The measurement of goodwill or gain from a bargain purchase is related, among other things, to the measurement of non-controlling interests, which has a direct impact on it. The aim of the paper is to analyze measurement in business combinations with a focus on speculative measurement, which may occur in business combinations. Measurement analysis is focused on the results of practical examples in individual areas of measurement with subsequent comparison and summary.

Keywords: measurement, business combinations, fair value

JEL classification: G34, M41

1 Introduction

Measurement is an important part of business combinations. Business combinations essentially include rules for the proper measurement of acquired assets and assumed liabilities, the measurement of non-controlling interests and, ultimately, the measurement of goodwill or profit from a bargain purchase. Fair value measurement is widely used in business combinations. However, in the case of non-controlling

interests, there is another option for measurement, which also affects the measurement of goodwill or gain from a bargain purchase.

There is room for speculation in areas where several methods of measurement are offered in the form of finding the best options for participants in business combinations. In this paper, we will focus on speculative measurement used primarily by the acquirer in a business combination.

However, the acquirer must not forget that it cannot think only of its advantages, but also of how attractive it is to third parties. There are many different groups of external users of business information, whose needs are more often in mutual contradiction [11].

The issue of business combinations is dealt with in International Financial Reporting Standard IFRS 3 Business Combinations (hereinafter “IFRS 3”). IFRS 3 contains several provisions regarding the measurement principle.

When measuring in business combinations, it is important to know the provisions of another International Financial Reporting Standard, which is IFRS 13 Fair Value Measurement (hereinafter “IFRS 13”). This standard deals with the general principles for fair value measurement, which is the basis for measurement in some areas within business combinations.

2 Theoretical Background

In this chapter, we present the theoretical knowledge and starting points of business combinations and measurement in business combinations.

2.1 Theoretical Background of Business Combinations

Theoretical knowledge of business combinations is based primarily on the International Standard IFRS 3. This standard contains several definitions in its appendix, including the definition of a business combination. A business combination is a transaction or other event in which the acquirer obtains control of one or more businesses [4]. Business combination refers to a company obtains control of another or a number of entities, or the joint result of two or more entities [12]. We will also refer to the acquirer as the parent entity and the acquiree as a subsidiary. International Standard IFRS 3 indirectly obliges the acquirer to analyze whether the transaction is a business combination as it is defined [3].

The central issue addressed in IFRS 3 is the acquisition method and its application. Each business combination is an acquisition that is accounted for in accordance with IFRS 3 by the only acceptable acquisition method [3]. The acquisition method consists of four basic steps [4]:

35. identifying the acquirer,
36. determining the acquisition date,
37. recognition and measurement of identifiable assets acquired, liabilities assumed and any non-controlling interests in the acquire,
38. recognition and measurement of goodwill or gain from a bargain purchase.

The identification of the acquirer should preferably be guided by the guidance for identifying parent entities in International Financial Reporting Standard IFRS 10 Consolidated Financial Statements (“IFRS 10”) and, if clarity is not achieved, each specific business combination should be analyzed for its particularities [4]. In accordance with the definition in IFRS 10, a parent is an entity that controls one or more entities [5].

The next step in the acquisition method is to determine the acquisition date by the acquirer. Under IFRS 3, this is the date on which the acquirer obtains control of the acquiree [4]. The acquisition date may or may not be the same as the date of the transaction, which means the date of the consideration, the acquisition of assets and the assumption of liabilities [3].

In applying the acquisition method, it is important that the identifiable assets acquired, liabilities assumed and all non-controlling interests in the acquiree are properly recognized and measured [4], because only then is it possible to identify the consolidation difference - goodwill or gain from a bargain purchase in the correct amount [3]. The subsidiary’s identifiable assets and liabilities might include assets and liabilities not previously recognized in the subsidiary’s financial statements [8]. The IFRS 3 recognition principle states that the acquirer shall recognize, at the acquisition date, separately from goodwill, identifiable assets acquired, liabilities assumed and any non-controlling interests in the acquiree, while respecting specified conditions to ensure that the fact is not distorted [4]. At the acquisition date, the acquirer shall analyze each item of assets acquired and liabilities assumed in accordance with other International Financial Reporting Standards [3]. The measurement principle states that the acquirer measures the identifiable assets acquired and liabilities assumed at fair value at the acquisition date [4]. We will take a closer look at the principle of measurement and measurement in business combinations in a separate section.

2.2 Theoretical Background of Fair Value Measurement

As the acquirer measures identifiable assets acquired and liabilities assumed at fair value at the acquisition date, it is important to disclose the basic knowledge about fair value in general. The issue of fair value is addressed in the aforementioned separate International Standard IFRS 13. This standard defines fair value as the price that would be received to sell an asset or paid to transfer a liability in a regular transaction between market participants at the measurement date [6].

IFRS 13 provides far-reaching guidance on how the fair value of assets and liabilities should be ascertained. This standard requires that the following are considered in determining fair value [8]:

39. the asset or liability being measured,
40. the principal market (i.e. that where the most activity takes place) or where there is no principal market, the most advantageous market (i.e. that in which the best price could be achieved) in which an orderly transaction would take place for the asset or liability,
41. the highest and best use of the asset or liability and whether it is used on a standalone basis or in conjunction with other assets or liabilities,
42. assumptions that market participants would use when pricing the asset or liability.

IFRS 13 provides a hierarchy of inputs for determining fair value, which is divided into three levels defined in Table 1:

Table 26. Fair Value Hierarchy.

Level inputs	Definition
Level 1	quoted prices in active markets for identical assets or liabilities that the entity can access at the measurement date
Level 2	inputs other than quoted prices included within Level 1 that are observable for the asset or liability, either directly or indirectly
Level 3	unobservable inputs for the asset or liability

Source: *IFRS 13 Fair Value Measurement*. 2011. IASB.

The fair value hierarchy proceeds from Level 1 to Level 3. The highest priority is given to quoted prices in active markets for identical assets or liabilities (Level 1 inputs) and the lowest priority to unobservable inputs (Level 3 inputs). Among the three Levels, Level 1 is clearly observable in the market. However, the Level 2 is measured based on observable inputs with adjustment and Level 3 is based on unobservable inputs or internal data [1]. In addition, entities with larger boards have lower information quality of entity-generated fair value estimates [10]. Level 1 is required where possible.

2.3 Theoretical Background of Measurement in Business Combinations

In connection with business combinations, we have introduced the fair value measurement principle. In practice, this means that, as part of consolidation, the acquirer must remeasure the assets and liabilities of each subsidiary to fair value, i.e. to revalue it at the acquisition date. Also, the acquirer discloses information that enables users to evaluate the nature and financial effects of the acquisition [2].

At the same time, the acquirer will measure all non-controlling interests in the acquiree (unless it owns 100% of the equity interests in the subsidiary), and may choose one of two alternatives [4]:

43. measurement of non-controlling interests at fair value; or
44. measurement by the proportionate share of non-controlling interests in the net identifiable assets of the acquiree.

The option for the acquirer in measuring non-controlling interests is an approach that does not promote uniformity in measurement but should take into account the differences in the specific conditions in which the business combination takes place [3].

Another area of measurement in business combinations is the measurement of goodwill or gain from a bargain purchase. The acquirer shall measure goodwill in excess of the amount obtained as a sum of:

45. the consideration transferred,
46. the amount of all non-controlling interests in the acquiree,

47. the fair value at the acquisition date of the acquirer's previously owned interest in the acquiree's equity (if the business combination is effected gradually) above the difference between the values of the identifiable assets and liabilities assumed (the net assets of the acquiree) measured in accordance with IFRS 3 [4]. Otherwise, if the net assets of the acquiree are higher than the sum of the mentioned values, it is the gain from a bargain purchase. The acquirer will measure the gain from a bargain purchase in the amount of the excess of net assets over the sum of all values. Assets and liabilities of the acquirer are carried forward at previous carrying amounts [9].

Identified goodwill or gain from a bargain purchase may be linked not only to shares acquired in the form of consideration transferred in a business combination, but also to non-controlling interests that the acquirer controls but does not own (owned by another investor). It is an approach to the identification of goodwill or gain of a bargain purchase, the result of which is the so-called full goodwill or full gain from a bargain purchase, which practically means that it is tied to 100% of the equity of the acquiree and not only to the share that is the subject of the acquisition. Full goodwill or gain from a bargain purchase is identified on the basis of non-controlling interests measured at fair value. If non-controlling interests are measured at proportionate share, then the goodwill or gain from a bargain purchase attributable to the non-controlling interests is not recognized. The specific amount of goodwill or gain from a bargain purchase thus depends on the chosen method of measuring non-controlling interests [3]. Full goodwill is part of assets and it is debatable whether its increase by a portion related to non-controlling interests is not misleading information about the amount of assets for users of consolidated financial statements due to the fact that the parent does not decide on share prices, for example when selling them. The parent entity only uses the net assets invested by other investors in business activities and values them. The same applies to the full gain from a bargain purchase, which is part of the revenue and ultimately affects profit or loss.

As the most disordered and debated topics there are considered to be accounting for goodwill, fair value measurement of non-controlling interests and impairment of intangible assets [7].

3 Methodology

The aim of this paper is to analyze measurement in business combinations with a focus on speculative measurement that may occur in business combinations.

The basis of measurement in business combinations is fair value, and the acquirer uses it to measure the acquired assets and assumed liabilities of the acquiree. Speculative fair value measurement may arise from situations in which the acquirer considers at what point in which it will enter into a business combination in order to provide the best terms for it. In addition, when measuring non-controlling interests, the acquirer has the option of measuring - on the basis of fair value or on the basis of a proportionate share. In the next steps, the measurement of non-controlling interests has an impact on other aspects related to business combinations, in particular the quantification of goodwill or gain from a bargain purchase, which again entices the

acquirer to speculate, trying to turn everything in its favor. This article focuses on speculative measurement.

First of all, the article offers an overview of the theoretical background for business combinations and measurements that are directly related to them. Based on theoretical knowledge, it is possible to proceed methodologically and reach results based on practical examples. Practical examples can be divided into three main parts, which are addressed:

- 48. measurement of acquired assets and assumed liabilities at fair value,
- 49. measurement of non-controlling interests at fair value and measurement of non-controlling interests on the basis of a proportionate share,
- 50. measurement of goodwill or gain from a bargain purchase.

The individual examples are based on fictitious assumptions and in some cases follow each other. The task of practical examples is to find situations that contribute to speculative measurement in business combinations. Based on the results of practical examples, an analysis is performed and then a comparison.

4 Results

In this section, we will reach practical results through practical examples, which we will use to analyze and compare individual measurement options in business combinations.

4.1 Measurement of Acquired Assets and Assumed Liabilities at Fair Value

Based on the measurement principle based on IFRS 3, all acquired assets and assumed liabilities are measured at fair value at the acquisition date. Possibilities for speculation in this case arise, for example, through the moment when a business combination occurs, respectively what will be the date of acquisition.

Suppose company A wants to buy 80% of the shares in company B. Company A is considering the date of the acquisition. Practical Example 1 and Practical Example 2 are based on the assumptions of different acquisition dates, and thus different fair values of the assets acquired and liabilities assumed. Company A would acquire the land and assume various liabilities by purchasing shares in company B, paying the same amount for the shares in both cases, i.e. € 75,000. We will abstract from liabilities in practical examples and focus only on the land.

Practical Example 1

Company A acquired the acquisition on January 1, 2021. The fair value of the land at that date is € 90,000.

Practical Example 2

Company A acquired the acquisition on July 1, 2021. The fair value of the land at that date is € 95,000.

Analysis and Comparison of Practical Examples 1 and 2

If company A were able to determine the fair value of the mentioned land in advance on the basis of the fair value measurement rules, it would be more advantageous from its point of view as from the acquirer's point of view until July 1, 2021, when it would acquire land with a higher fair value for the same amount. However, if it had already acquired the acquisition on January 1, 2021, the land could be revalued when the consolidated financial statements were prepared. Each acquiring company must consider what is more advantageous for it and what results it needs to report at the moment in order to be attractive to third parties.

4.2 Measurement of Non-Controlling Interests

As mentioned above, non-controlling interests may be measured at fair value or at proportionate share. The choice of measurement affects other aspects of business combinations.

Assume that company A has purchased an 80% interest in company B, with the remaining 20% owned by company C. At the acquisition date, company B's net assets represent € 100,000.

Practical Example 3 - Fair Value

In the case of measuring non-controlling interests at fair value, we need to know, for example, the fair value per 1% of the interest. Assume that 1% = € 1,750. The non-controlling interest in fair value represents $1,750 \text{ [€]} \times 20 \text{ [%]} = € 35,000$.

Practical Example 4 - Proportionate Share

In the case of valuation of non-controlling interests by a proportionate share, we calculate the non-controlling interest as 20% of net assets, i.e. $20\% \text{ of } € 100,000 = € 20,000$.

Analysis and Comparison of Practical Examples 3 and 4

From the results of non-controlling interests, we see that the choice of measurement option affects the value of such interests. In practical example 3, the value of the non-controlling interest is higher by € 15,000 than in practical example 4. At the moment, we can only conclude that their values differ, which we have also compared on the basis of the difference. Different values will affect the calculation of goodwill or gain from a bargain purchase.

4.3 Measurement of Goodwill or Gain from a Bargain Purchase

The measurement of goodwill or gain from a bargain purchase depends on several of the mentioned aspects. It is also significantly affected by the measurement of non-controlling interests.

To quantify goodwill or gain from a bargain purchase, we need to know the fair value of the consideration transferred by the acquirer for the interests, the value of the non-controlling interests and the fair value of the interests previously held by the acquirer. The sum of these values represents the fair value of the acquiree, and we further compare it with the fair value of net assets, which is € 100,000. To illustrate the effect of measuring non-controlling interests, we will quantify goodwill or gain from a bargain purchase over the values of non-controlling interests in Practical Examples 3 and 4. The other values will be the same in comparative Practical Examples 5 and 6.

Practical Example 5 - Non-Controlling Interests at Fair Value

The assumptions for calculating the fair value of the acquiree are in Table 2:

Table 2. Assumptions – Non-Controlling Interests at Fair Value.

Item	Value (€)
Fair Value of the Consideration Transferred	75,000
Non-Controlling Interests at Fair Value	35,000
Fair Value of the Acquirer's Previously Held Equity Interests	0

Source: Own Processing.

The sum of the stated values shows that the fair value of the acquiree is € 110,000. By comparing with the fair value of net assets, we find that the fair value of the acquiree is € 10,000 higher than the net assets. This means that goodwill of € 10,000 arises. As non-controlling interests are measured at fair value, goodwill is referred to as full goodwill, i.e. goodwill is measured at the amount of the acquirer's interests as well as the non-controlling interests.

Practical Example 6 - Non-Controlling Interests at Proportionate Share

The assumptions for calculating the fair value of the acquiree are in Table 3:

Table 3. Assumptions – Non-Controlling Interests at Proportionate Share.

Item	Value (€)
Fair Value of the Consideration Transferred	75,000
Non-Controlling Interests at Fair Value	20,000
Fair Value of the Acquirer's Previously Held Equity Interests	0

Source: Own Processing.

The sum of the stated values shows that the fair value of the acquiree is € 95,000. By comparing with the fair value of net assets, we find that in this case the net assets are higher, by € 5,000. This means that gain from a bargain purchase worth € 5,000 arises. As non-controlling interests are measured on a proportionate share, the gain from a bargain purchase is referred to as the partial gain from a bargain purchase, i.e. it is calculated at a value that is attributable only to the acquirer's shares.

Analysis and Comparison of Practical Examples 5 and 6

Practical Examples 5 and 6 are clear evidence of how the choice of measuring non-controlling interests affects other aspects of business combinations. In the case where the fair value measurement of non-controlling interests was used, goodwill arose. Conversely, in the case where the measurement of non-controlling interests by a proportionate share was used, a gain from a bargain purchase was made. This situation could give the acquirer room to speculate and consider how to measure non-controlling interests.

Another difference can be seen in the fact that in the case of fair value measurement it is full goodwill (or full gain from a bargain purchase) and in the case of proportionate share it is a partial gain from a bargain purchase (or partial goodwill). This situation also gives the acquirer room for speculation and a decision on what is more suitable for it at a given moment.

Under those conditions, the acquirer must decide whether it is more advantageous for it to recognize goodwill that is part of the assets in the consolidated financial statements or to recognize a gain from a bargain purchase that is part of the revenue in the consolidated financial statements and ultimately affects consolidated profit or loss.

5 Conclusions

Business combinations could not have arisen if the measurement area had not been linked to them. The area of measurement gives acquirers in business combinations room for various speculations, which we have shown on practical examples based on theoretical knowledge about business combinations and measurement associated with them.

If the acquirer has information about the acquired assets in advance, he can dispose of such information to his advantage. Based on the measurement principle in business combinations, the assets acquired and the liabilities assumed must be measured at fair value. Depending on the time at which the acquisition date occurs, the acquirer can assess whether the current business combination is beneficial to him.

In addition, the acquirer also has the option of measuring, in particular the measurement of non-controlling interests. He may choose to measure at fair value or a proportionate share measurement. This again gives the acquirer room for his own speculation and decision-making to his best advantage.

The option to measure non-controlling interests further affects whether goodwill or gain from a bargain purchase arises and whether full or partial goodwill or gain from a bargain purchase is recognized. The acquirer can decide again.

However, decisions are not always purely up to the acquirer, and it is not right for the acquirer to look solely for their own benefit. It must also ensure that it remains attractive in the eyes of third parties for future business activities, be they business partners, state institutions or the banking sector.

In conclusion, we state that we managed to meet our set aim. We introduced, analyzed and compared several options for speculative valuation in business combinations, which we wanted to point out that the provisions relating to business combinations are not always perfect and if acquirers know the individual measurement options, they can deal with information speculatively.

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Value at Risk implementation in business practice

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Abstract.

Value at Risk (VAR) is a frequently used risk measure. Its concept based on determination of maximal loss for predetermined level of certainty is easy to understand. It is often used by various corporate professionals to measure different risks in the company, but predominantly banking and investment sector is responsible for growth of this approach. The rapid growth of instruments in financial market, support growth of VAR estimation methods, as well as methods for proper validation of this models. Presented paper goes beyond traditional financial instruments and tries to assess usefulness of three different VAR estimation models in cryptocurrency market. The motivation behind this research is to determine whether Normal, Historical or EWMA approaches of VAR estimation can be used for determination of maximal loss in cryptocurrency market with 95% and 99% probability. The performance of these VAR model is measure by number of violations and four different backtests: Basel's Traffic light approach, Binomial test, POF test and TBF test. The results showed that performance of these VAR models differs based on the type of cryptocurrency and that VAR models perform differently at pre-COVID-19 and during COVID-19 period.

Keywords: Risk, VaR methodology, risk classification

JEL classification: G24, G31

1 Introduction

In the corporate environment there are several well-known concepts, which are used to measure risk. There is a beta which is used to measure volatility of systematic risks, r-squared for measurement of correlation between asset and benchmark, standard deviation as a measure of volatility and Sharpe ratio which measure performance adjusted for risks). (Likitratcharoen et al., 2018) Value at Risk concepts fall into that category. It was presented by J.P. Morgan in 1994 and became widely used methodology for determination of risks of various financial instruments such as stock, bond, options, futures. (Likitratcharoen et al., 2018). The concept behind VAR is easy to understand and can be applied to support investment decisions in almost all traditional financial instruments. The demand for cryptocurrencies increased so heavily, that there are considered by some authors as new class of investments products. (Corbet et al., 2018, Boako et al., 2019). Therefore, it is not surprise that there is a rapid increase of scientific studies which implement the time-tested concepts from traditional financial markets to cryptocurrency markets. Current studies covers topics like price determination (Kristoufek, 2015; Ciaian et al., 2018), information exchange between different cryptocurrencies and investments instruments (Corbet et al., 2018), technical issues connected to cryptocurrency environment (Dwyer, 2015; Bariviera et al., 2017a), cryptocurrency hedging strategies (Dyhrberg, 2016; Bouri et al., 2017), interconnection of returns and volumes of cryptocurrencies (e.g. Balciar et al., 2017), trading (Blau, 2017; Corbet et al., 2018), volatility (Katsiampa, 2017), Efficient market theory on cryptocurrency markets (e.g., Urquhart, 2016; Bariviera, 2017b; Nadarajah and Chu, 2017), and cost of cryptocurrencies transactions (Kim, 2017). (Boako et al., 2019) Current rapid growth of cryptocurrency market and use of cryptocurrencies as a part of corporate investment strategies open the question, whether VAR models can be usefully implemented in fintech sector. This paper tries to contribute to this scientific discussion by testing several VAR models on three major cryptocurrencies in pre-COVID-19 and during COVID-19 two years periods.

2 Methodology and data

This paper is focused on implementation of Value at risk methodology (VAR) in business practice to support decision making of investors regarding their positions in cryptocurrency market. The analyses conducted in this article tries to validate, whether VAR can be used to estimate losses from cryptocurrency trading based on some predefined level of confidence. In order to estimate VAR, we selected three frequently used methods: 1. VAR estimation using Normal distribution method. 2. VAR estimation using the Historical Simulation Method. 3. VAR using the Exponential Weighted Moving Average Method (EWMA). First model assume that the profits and losses are normally distributed. Second model represents nonparametric method, which is not so depended on distribution variables because it is based on quantiles. Based on this model present VAR is determined as the predefined th-quantile of last several returns determined by examination window. The last model is on the other hand based on

assumption that not-so-distant past returns influence current return more than returns farther in the past, so the Exponential Weighted Moving Average is used for calculations of VAR. The examination window used in all three models is set to 250 days, based on assumption that general year has 250 trading days. For more information, please see Farid (2010). In term of level of confidence for VAR, we use two most frequently used levels of VAR: VAR 95% and VAR 99%. The sample data includes prices of three major (based on market capitalization) cryptocurrencies: Bitcoin, Ethereum and Litecoin. The dataset contains prices from 1.4.2017 to 2.8.2021 for all three cryptocurrencies. On the other hand, having in mind size of the rolling examination window and current market environment, the dataset was divided to two sub samples. For this subsamples VARs were calculated. First subsample represents pre-COVID-19 period. The first VARs calculated within this subsample have the date 1.1.2018 and the last VARs have the date 31.1.2019. The second period covers prices of cryptocurrencies within COVID-19 outbreak. The first VARs calculated within COVID-19 period have a date 1.1.2020 and last VARs have a date 2.8.2021. Both datasets include prices covering mentioned period plus prices of 250 days before first date. The descriptive statistics of datasets for every cryptocurrency and every sub-sample are presented in Table 1.

Table 1: Overview of descriptive statistics of the research sample

		n	Mean	Median	St. Dev.	Var. coef.	Min.	Max.	Q1	Q3
Bitcoin Price	Pre-COVID-19	730	7463	7353	2532	0,34	3233	17172	6167	9142
	COVID-19	580	23315	11920	17440	0,75	4917	63558	9345	35917
Ethereum Price	Pre-COVID-19	730	331	211	261	0,79	84	1385	161	451
	COVID-19	580	963	402	951	0,99	110	4178	231	1792
Litecoin Price	Pre-COVID-19	730	87,45	72,78	50,78	0,58	23,12	278,92	53,20	117,16
	COVID-19	580	105,14	64,72	74,53	0,71	30,49	388,28	46,67	151,94

Source: author

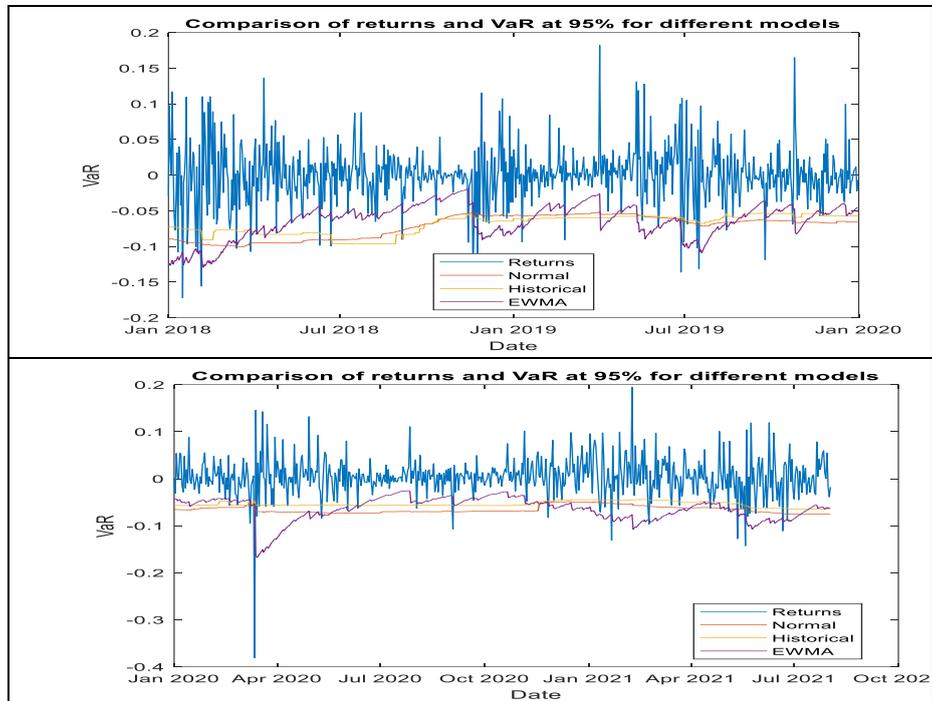
The VARs models are validated by several backtests. First one is Traffic light approach, which was established by Basel committee in 2013. For example, in case of 250 observations green zone allow less than five violations. Five to nine violations (for 250 observations) represent yellow zone and mean that model can be either precise or imprecise. The trust in model accuracy decreases, with the increasing number of violations. For 250 observations, the red zone is defined by more than 9 violations. (Roccioletti, 2015). Second backtesting test is based on Binomial distribution and it is used to test whether „the unconditional probability of a violation in the risk model, significantly differs from the conjectured probability. (Roccioletti, 2015) The third backtesting test is known as POF-test or as a Kupiec Test. The Proportion Of Failure test measures whether “there is a large discrepancy between the observed failure rate, \hat{p} and the theoretical failure rate p .” (Roccioletti, 2015) The third backtesting approach is based on TBF test which is abbreviations for Time Between Failure. This test is also known as Mixed Kupiec Test. This test “measure time between exceptions, being able (at least potentially) to capture various form of dependence.” (Roccioletti, 2015). For more information regarding all backtesting models, please see Roccioletti, (2015).

3 The results of the research

As was mentioned in methodology, the research in this paper analyses use of three major Value at risk estimation techniques in cryptocurrency market. It has two parts. First part is focusing on estimation of VAR95 and VAR99 models and their efficiency in term of expected violations versus actual violations. The aim of provided analyses is to compare efficiencies of VAR models in pre-COVID-19 and during COVID-19 period. Second part of the research is dealing with the backtesting of estimated VAR models. Here also, the validity of the models are tested in pre-COVID-19 and during COVID-19 period.

First analysed cryptocurrency is Bitcoin. The analysis of the different approaches of VAR95's estimation in the periods before COVID-19 and during COVID-19 is presented in Figure 1.

Figure 1: Comparison of returns and VAR95s in per-COVID-19 and COVID-19 period for Bitcoin



Source: Authors

As can be seen on Figure 1, returns presented in COVID-19's sample are characterized by greater volatility (see variation coefficient) and bigger spikes (see max value) than the returns in post-COVID-19 sample. The VARs estimated by Normal and Historical approach are close to each other and VARs estimated by EWMA approach are more volatile. In order to measure the performance of VAR models, the Table 2 was created. It showed comparison between number of violations expected from VAR models and actual violations of VAR models. The Ratio lesser than one, means that number of actual violations is lower than number of violations predicted by VAR, and therefore VAR was able to predict maximal loss at predefined level of confidence.

Table 2: Overview of Bitcoin's VAR models violations in pre-COVID-19 and COVID-19 period

Bitcoin						
	Pre-COVID-19			COVID-19		
VaRID	Failures	Expected	Ratio	Failures	Expected	Ratio
Normal 95	34	36,50	0,9315	22	29	0,758621
Historical95	35	36,50	0,9589	36	29	1,241379
EWMA 95	34	36,50	0,9315	21	29	0,724138

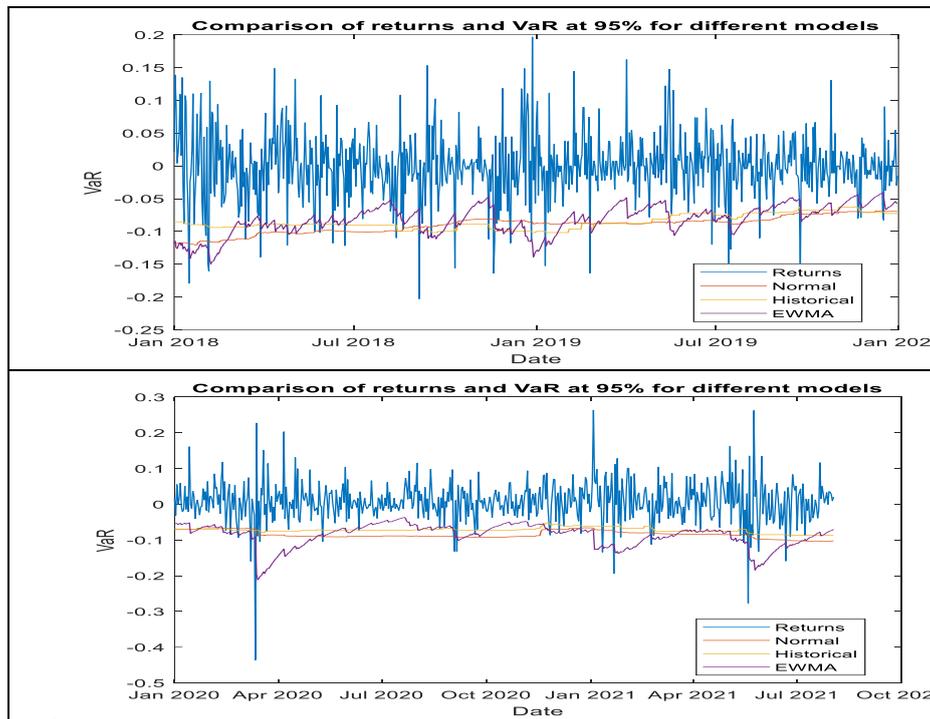
Normal 99	13	7,30	1,7808	9	5,8	1,551724
Historical99	7	7,30	0,9589	7	5,8	1,206897
EWMA 99	13	7,30	1,7808	7	5,8	1,206897

Source: Authors

The Table 2 shows that in pre-COVID-19 period, the VAR at 95% has the ratio smaller than one for all three estimation methods and VAR at 99% have similar ratio at the same period only historical estimation method. The situation is different for VARs estimated during COVID period. Results shows that ratio smaller than one is presented only on VAR at 95% based on normal distribution or EMWA. These results suggest that only VAR95 estimated based on normal distribution and based on EWMA method have fewer violations that was predicted for both pre-COVID-19 and COVID-19 periods.

Second analysed cryptocurrency is Ethereum. The analysis of the different approaches of VAR95's estimation in the periods before COVID-19 and during COVID-19 is presented in Figure 2.

Figure 2: Comparison of returns and VAR95s in per-COVID-19 and COVID-19 period for Ethereum



Source: Authors

Similarly, to Bitcoin, also Ethereum's timeseries presented in Figure 2 behave differently when the pre-COVID-19 and COVID-19 periods are compared. Also, in this case the returns from COVID-19 period are characterized by greater volatility and have bigger spikes than the returns in pre-COVID-19 sample. Correspondingly, the VARs estimated by Normal and Historical methods are close to each other and more smother, than VARs estimated by EWMA approach, which are more volatile. The performance of VAR models is analysed based on results presented in the Table 3. This table compare number of violations expected from VAR models and actual violations of VAR models. If Ratio value is smaller than one, it means that the number of actual violations is smaller than number of violations predicted by VAR, and therefore VAR was able to predict maximal loss at predefined level of confidence for Ethereum cryptocurrency.

Table 3: Overview of Ethereum's VAR models violations in pre-COVID-19 and COVID-19 period

Ethereum						
	Pre-COVID-19			COVID-19		
VaRID	Failures	Expected	Ratio	Failures	Expected	Ratio
Normal 95	32	36,5	0,876712	26	29	0,896552
Historical 95	37	36,5	1,013699	35	29	1,206897
EWMA 95	40	36,5	1,09589	20	29	0,689655
Normal 99	10	7,3	1,369863	8	5,8	1,37931
Historical 99	7	7,3	0,958904	8	5,8	1,37931
EWMA 99	18	7,3	2,465753	7	5,8	1,206897

Source: Authors

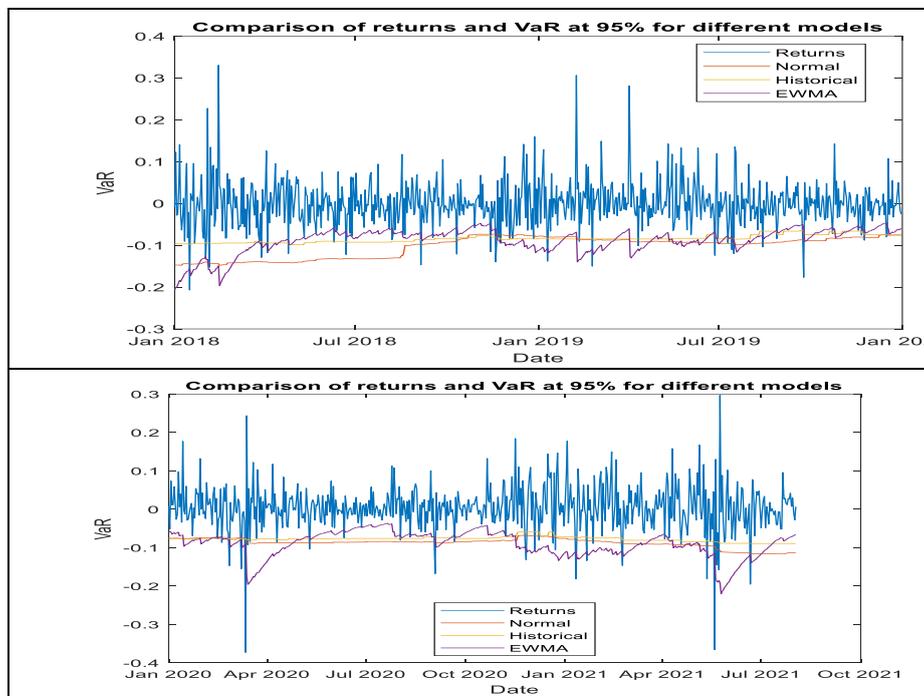
The Table 3 suggest that in pre-COVID-19 period, the VAR models at 95% has the ratio smaller than one only for normal estimation method and VAR models at 99% have similar ratio for the same period only for historical estimation method. The situation is different for VARs estimated during COVID period. Results shows that ratio smaller than one is presented for VAR at 95% in case of normal and EWMA estimation. These results suggest that only VAR95 estimated based on normal distribution has fewer violations that was predicted for pre-COVID-19 and COVID-19 periods.

Last analysed cryptocurrency is Litecoin. The overview of the different approaches of VAR95's estimation in the periods before COVID-19 and during COVID-19 is presented in Figure 3.

Similarly, to Bitcoin, Ethereum also Litecoin behave differently when two testing periods are compared. The Litecoin return timeseries in COVID-19 period shows greater volatility and has bigger spikes than the returns in pre-COVID-19 sample.

Parallely, the VARs estimated by Normal and Historical methods are close to each other and more smother, than VAR models estimated by EWMA approach. which are more volatile. The performance of VAR models is analysed based on results presented in the Table 4. The results compare number of violations expected from VAR models and actual violations of VAR models. If Ratio value is smaller than one, it means that the number of actual violations is smaller than number of violations predicted by VAR, and therefore VAR was able to predict maximal loss at predefined level of confidence for Litecoin cryptocurrency.

Figure 3: Comparison of returns and VAR95s in per-COVID-19 and COVID-19 period for Litecoin



Source: Authors

The results present in Table 4 shows that in pre-COVID-19 period, the VAR models at levels 95% and 99% has the ratio smaller than one for all estimated models except for VAR99 estimated by EWMA approach. For COVID-19 period, table shows that ratio smaller than one was determined for VAR at 95% in case of normal and EWMA estimation. The VAR models which have fewer violations than predicted, for both of examined periods are models estimated at 95% level using normal and EWMA approach.

Table 4: Overview of Litecoin's VAR models violations in pre-COVID-19 and COVID-19 period

Litecoin						
	Pre-COVID-19			COVID-19		
VaRID	Failures	Expected	Ratio	Failures	Expected	Ratio
Normal 95	24	36,5	0,657534	23	29	0,793103
Historical 95	36	36,5	0,986301	30	29	1,034483
EWMA 95	36	36,5	0,986301	22	29	0,758621
Normal 99	7	7,3	0,958904	14	5,8	2,413793
Historical 99	7	7,3	0,958904	12	5,8	2,068966
EWMA 99	11	7,3	1,506849	9	5,8	1,551724

Source: Authors

The second part of research is focused on backtesting of VAR models. We implement four frequently used tests to validate VAR models with different estimation techniques. First analysed cryptocurrency is Bitcoin. The results of the executed backtests are presented in table below. (Table 5)

Table 5: The results of Bitcoin's backtests in pre-COVID-19 and COVID-19 period

Bitcoin								
	Pre-COVID-19				COVID-19			
VaRID	TL	Bin	POF	TBF	TL	Bin	POF	TBF
Normal 95	'green'	'accept'	'accept'	'reject'	'green'	'accept'	'accept'	'reject'
Historical 95	'green'	'accept'	'accept'	'reject'	'green'	'accept'	'accept'	'reject'
EWMA 95	'green'	'accept'	'accept'	'accept'	'green'	'accept'	'accept'	'accept'
Normal 99	'yellow'	'reject'	'accept'	'reject'	'green'	'accept'	'accept'	'accept'
Historical 99	'green'	'accept'	'accept'	'accept'	'green'	'accept'	'accept'	'accept'
EWMA 99	'yellow'	'reject'	'accept'	'accept'	'green'	'accept'	'accept'	'accept'

Source: Authors

According to Table 5, comparing pre-COVID-19 period and COVID-19 period, results showed that VAR models have better backtests' results in second timeseries. n

pre-COVID-19 period, the performed backtests together accepts only VAR95 model estimated by EWMA and Historical VAR99 model. On the other hand, in COVID-19 period, all tests except for the TBF, accept all examined VAR models. For the same period, the TBF tests rejects VAR95 models using normal and historical approach. Based on these results only VAR95 model estimated by EWMA and Historical VAR99 model were accepted by all backtests for both periods using Bitcoin timeseries.

Next cryptocurrency that was backtested is Ethereum. The results of the backtests are presented in table below. (Table 6)

Table 6: The results of Ethereum's backtests in pre-COVID-19 and COVID-19 period

Ethereum								
	Pre-COVID-19				COVID-19			
VaRID	TL	Bin	POF	TBF	TL	Bin	POF	TBF
Normal95	'green'	'accept'	'accept'	'accept'	'green'	'accept'	'accept'	'reject'
Historical 95	'green'	'accept'	'accept'	'accept'	'green'	'accept'	'accept'	'reject'
EWMA 95	'green'	'accept'	'accept'	'reject'	'green'	'accept'	'accept'	'accept'
Normal 99	'green'	'accept'	'accept'	'accept'	'green'	'accept'	'accept'	'accept'
Historical 99	'green'	'accept'	'accept'	'accept'	'green'	'accept'	'accept'	'accept'
EWMA 99	'yellow'	'reject'	'reject'	'reject'	'green'	'accept'	'accept'	'accept'

Source: Authors

Based on the results of Table 6, similarly to Bitcoin's results also Ethereum backtests' results from COVID-19 period are better than results analysing pre-COVID-19 period. In pre-COVID-19 period, the performed backtests together accepts all VAR models estimated by normal and historical approach. On the other hand, in COVID-19 period, parallely to Bitcoin's results all tests except for the TBF, accept all examined VAR models. For the same period, the TBF tests rejects same two models it was when Bitcoin was tested. The models were the VAR95 using normal and historical approach. Based on these results only VAR99 model estimated by normal and historical approach were accepted by all backtests for both periods using Ethereum timeseries.

The last backtested cryptocurrency was Litecoin. The results of the backtests are presented in table below. (Table 7)

Table 7: The results of Litecoin's backtests in pre-COVID-19 and COVID-19 period

Litecoin								
	Pre-COVID-19				COVID-19			
VaRID	TL	Bin	POF	TBF	TL	Bin	POF	TBF
Normal 95	'green'	'reject'	'reject'	'reject'	'green'	'accept'	'accept'	'reject'
Historical 95	'green'	'accept'	'accept'	'reject'	'green'	'accept'	'accept'	'reject'
EWMA 95	'green'	'accept'	'accept'	'reject'	'green'	'accept'	'accept'	'accept'
Normal 99	'green'	'accept'	'accept'	'accept'	'yellow'	'reject'	'reject'	'reject'
Historical 99	'green'	'accept'	'accept'	'accept'	'yellow'	'reject'	'reject'	'reject'
EWMA 99	'green'	'accept'	'accept'	'reject'	'green'	'accept'	'accept'	'accept'

Source: Authors

As can be seen on Table 7, backtests results of Litecoin timeseries are slightly different that Bitcoin's or Ethereum's results. In pre-COVID-19 period, the performed backtests together accepts only VAR models at 99% level estimated by normal and historical approach. Analysing COVID-19 timeseries, the results showed that only VAR models estimated by EWMA approach are accepted by all used backtesting methods. These results suggests that, in case of Litecoin none of tested VAR models were accepted by all backtests conjointly in tested both periods.

4 The conclusions

Presented paper deal with implementation of Value at Risk methodology in business practice. The motivation behind this research is to determine whether Normal, Historical or EWMA approaches of VAR estimation can be used for determination of maximal loss in cryptocurrency market with 95% and 99% probability. Results showed that performance of these VAR models differs based on the type of cryptocurrency and that VAR models behave differently at pre-COVID-19 and during COVID-19 period. From all tested VAR models only VAR at level 95% estimated by normal approach has fewer violations (failures) than expected for all three examined currencies in both tested periods. In case of Bitcoin and Ethereum this type of VAR model was also accepted by all used backtests except for TBF test which is dealing with Time Between Failure. On the other hand, for Bitcoin and Ethereum we find some VAR models which are accepted by all used backtest (even by TBF test) for both examined periods. However, these models are different for Bitcoin and different for Ethereum and they had higher number of violations than was expected in one of the tested periods. In term of Litecoin no suitable model which was accepted by all backtests in both periods was found.

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Inflation Dynamics & Real Economic Activity: Examination of the Cost-Based Hybrid New Keynesian Phillips Curve for the Czech Republic

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Abstract. The New Keynesian Phillips Curve (NKPC) became a staple in the New Keynesian economics, assuming an existence of a short-term trade-off between inflation and real economic activity, either in a form of labor unit costs or output gap. Extending the cost-based NKPC with hybrid, backward-looking price setting to the Czech Republic, we aim to examine the impact of unit labor costs, inflation expectations, import prices and real effective exchange rate on the development of inflation between 2000M1 and 2020M12. Dealing with non-stationary and cointegrated time series, we compare results employing an Error Correction Model (ECM) and an Autoregressive Distributed Lag (ARDL) model with the variables integrated in order $I(1)$. Our data result suggest that the labor unit costs, and the inflation expectations might have an impact on the evolution of inflation based on the ECM and ARDL in differences for the Czech Republic between 2000M1 and 2020M12, although the results are too uncertain to be unambiguous.

Keywords: expected inflation, real marginal costs, New Keynesian Phillips Curve, the Czech Republic

JEL classification: C32, E31, F42

1 Introduction

Ever since Phillips (1958) first observed a negative relationship between the unemployment rate and the rate of wage inflation in data for the United Kingdom,

Samuelson & Solow (1960: 192) presented what they coined the Phillips curve as a “menu” for policy-makers and Phelps (1967) along with Friedman (1968) upgraded this framework with expected inflation, the Phillips curve, or the short-run trade-off between inflation and real economic activity, became a cornerstone of the modern monetary policy. As the “original” Phillips curve seemed unable to provide cogent explanation to chronically high inflation rates and unemployment in the 1970s, new macroeconomic approaches started to emerge, mainly the New Keynesian Phillips curve (NKPC).

New Keynesianism, building mainly on the work of Fisher (1977) and Taylor (1980), emphasize forward-looking behavior, imperfect competition and Calvo’s (1983) principle of “staggered prices”. Naturally, these microeconomic foundations were incorporated into the NKPC as well, especially following the Lucas critique (Neiss & Nelson, 2002). In case of the NKPC, authors substituted inflation expectations for lagged inflation into the Phillips curve and showed short-run trade-off between the real economic activity and price inflation. The NKPC was first popularized by Roberts (1995, 2001), with follow up by Sbordone (1998, 2001), Galí & Getler (1999), Galí et al. (2001) and Galí & Monacelli (2005). Galí et al. (1999) pioneered the estimation of the so called “hybrid” NKPC, incorporating both forward- and backward-looking agents, trying to capture inflation persistence. The ample empirical evidence on the hybrid NKPC confirmed importance of incorporating the lagged inflation into the model (Rudd & Whellan, 2007).

Comparing the NKPC with the original Phillips curve, we are able to identify two distinct features. Firstly, New Keynesian models assume forward looking, in case of the hybrid NKPC also backward-looking agents, where firms set prices on the bases of their expectations about the future development of cost factors. Thereby, the (hybrid) NKPC is based on inflation expectations and lagged inflation. Secondly, the NKPC shifts from the relationship between inflation and unemployment to the short-run trade off between inflation and real economic activity. The real economic activity tends to be proxied either via real marginal costs or output gap. Empirical evidence seems to indicate that employment of the real marginal cost delivers more satisfying results than the output gap, resulting into preference of the cost-based NKPC over the gap-based NKPC (Galí & Gertler, 1999).

In this article, aim to examination short-run trade-off between inflation and real economic activity, using the cost-based hybrid NKPC in the case of the Czech Republic. The article is structured as follows. Firstly, we derive the cost-based hybrid NKPC equation, which will be examined for the Czech Republic. Subsequently, we review the literature dealing with the (hybrid) NKPC in general, and then specifically in the case of the Czech Republic. Secondly, we describe the data used in article, providing detailed account of our methodology and model-building. Lastly, we present results from the ECM and ARDL, both in differences and levels, models with regards to the cost-based hybrid NKPC in the Czech Republic between 2000M1 and 2020M12. All the calculations, data adjustments and modelling in this article were conducted using the R programming language.

2 Literature review

In its basic cost-based form, the NKPC, stemming from the New Keynesian dynamic stochastic general equilibrium model, which is based on the utility maximizing households and profit-maximizing firms.¹ Only a fraction of firms $(1 - \theta)$ has a capacity to adjust prices in period t , where θ is a measure of price-stickiness, and future developments are discounted by a factor β . The NKPC can be expressed as:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda mc_t^r + \varepsilon_t ; \quad (1)$$

where $E_t \pi_{t+1}$ are the inflation expectations observed at time t , mc_t^r real marginal cost with $\lambda = \frac{(1-\theta)(1-\theta\beta)}{\theta}$ and ε_t is a disturbance term.² Fuhrer (1997) and Galí & Gertler (1999), establishing an upgraded, “hybrid” form of the NKPC, argue that it is needed to take into consideration lagged inflation on top of the forward inflation expectations. Purely forward-looking NKPC would enable a costless trade-off between economic activity and inflation and omits the persistence of firms’ behavior. Thus, the hybrid NKPC with its backward-looking price setting can be defined as follows:

$$\pi_t = \gamma_f E_t \pi_{t+1} + \gamma_b \pi_{t-1} + \lambda mc_t^r + \varepsilon_t ; \quad (2)$$

where π_{t-1} represents a lagged inflation, and coefficients γ are functions of structural parameters coming from the New Keynesian model of a small economy.³ In order to ensure linear homogeneity of inflation, the assumption $\gamma_f + \gamma_b = 1$ must hold. Lagged variables prevent instantaneous inflation and output adjustments to unanticipated shocks.

The Czech Republic, not being a Eurozone member state, is exposed to exchange rate dynamics. External shocks, in a form of the exchange rate deviation, translate through the transmission mechanism inevitably into domestic inflation via two channels, directly through the import prices and indirectly through the impact of the real exchange rate on real economy. When added to the model in compliance with Milučká (2014), the NKPC can be expressed as:

¹ These firms assumed to be in monopolistic competition, are identical with the exception of differenced products and pricing history and face the same constant elasticity demand.

² The coefficient λ depends negatively on θ and β . Thus, inflation is less sensitive to the value of real marginal cost if θ is large. In case of full price rigidity, $\theta = 1$, λ equals 0 and inflation does not depend on the real marginal costs anymore (Danišková & Fidrmuc, 2011: 3).

³The ability of policy-makers to have inflation under control is dependent on relative magnitudes of these coefficients (Hornstein, 2008). Galí & Getler (1999) describe them as follows: $\gamma_f \equiv \theta\beta\varphi^{-1}$; $\gamma_b \equiv \omega\varphi^{-1}$; $\lambda \equiv (1 - \beta\theta)(1 - \omega)(1 - \theta)\varphi^{-1}$ and $\varphi \equiv \theta + \omega[1 - \theta(1 - \beta)]$.

$$\pi_t = \gamma_f E_t \pi_{t+1} + \gamma_b \pi_{t-1} + \lambda mc_t^r + im_{t-1} + REER_{t-1} + \varepsilon_t ; \quad (3)$$

where $REER_{t-1}$ is a lagged impact of the real exchange rate and im_{t-1} a lagged value of import prices, assuming the linear homogeneity of inflation $\gamma_f + \gamma_b = 1$ holds. Import prices im_t are an essential determinant of a supply side effect for inflation, especially in small open economy (Milučká, 2014). The hybrid NKPC in this form states that inflation rate depends on expected inflation (forward-looking component), lagged inflation (backward-looking component), real marginal cost, import prices and REER.

The literature assessing the hybrid NKPC is rather ample. Jondeau & Le Bihan (2005) estimates the hybrid NKPC specification with three lags and leads and a low degree of forward-looking expectations for continental Europe. Nason & Smith (2008) study the hybrid NKPC under GNM for the USA, the UK, and Canada and Jean-Babstiste (2012), for instance, estimates the hybrid NKPC using survey forecasts of inflation for United Kingdom, and concludes that these forecasts improve estimates of the hybrid MKPC. Kuester et al. (2007) and Roeger & Herz (2012) conduct similar research.

Numerous authors applied the NKPC in the context of the Czech Republic as well. One of the first were Arlt & Plašil (2005) concluding that the NKPC model is not suitable in conditions of the Czech Republic, since it does not describe the inflation process sufficiently. Danišková & Fidrmuc (2011), employing the GMM model and the FIML model, estimate the hybrid New Keynesian Phillips Curve for the Czech Republic during the period from 1996 to 2009 finding out that the GMM results are likely to be more biased when the output gap is used as a proxy for real marginal costs. They conclude that the NKPC is flatter in the Czech Republic, when compared to other EU countries. Vašíček (2011) explores the inflation dynamics of the V4 countries by means of econometric estimation of the NKPC, arguing that the output gap performs slightly better than the average real marginal costs (ULC) in determining inflation rate in the short-run. Milučká (2014) also estimates parameters of the hybrid output-based NKPC model, as opposed to traditional cost-based NKPC, for the Czech Republic between 2000 and 2012 using Kalman filtration.

3 Data and Methodology

3.1 Data

Data used in this article consists of monthly time series from 2000M1 to 2020M12, retrieved from the Czech National Bank (ARAD) and the Czech Statistical Office (CSZO). Each time series is transformed into logarithms and seasonally adjusted using the x11 regression from the “X-13ARIMA-SEATS” R package. As an inflation proxy, we opted for the annualized monthly change of seasonally adjusted logged Consumer Price Index (logCPI), where 2015=100. Import prices (logIM) are proxied by change of logged seasonally adjusted index of import prices (2015=100). As a proxy for expected inflation, we use the CNB’s monthly data from Survey of Professional

Forecasters. These data represent financial market inflation expectations for one-year horizon ($\log\text{SPF}_{1y}$). Even though the SPF tends to be disregarded for the most part, they were used as a proxy for inflation expectations, for instance, by Babtiste (2012), Binder (2015), Coibion & Gorodnichenko (2015) or Ball & Mazumder (2018). The logged seasonally adjusted real effective exchange rate (REER) is defined as a monthly nominal effective exchange rate of the CZK deflated by CPI and weighted by foreign trade turnover, where 2015=100. Lastly, the real marginal costs are practically unobservable. Danišková & Fidrmuc (2011), however argue that the real marginal costs under the assumption of the Cobb-Douglas production technology can take a form of labor income share or equivalently real unit labor costs. In our model, labor costs are proxied via logged and seasonally adjusted real unit labor cost (RULC) index, defined as real labor productivity per person, where 2015=100. Since only quarterly data are available, we disaggregate them into monthly time series using Denton-Cholette method, employing “tempisagg” R package (Dagum & Cholette, 2006). All the data are displayed in Figure 1.

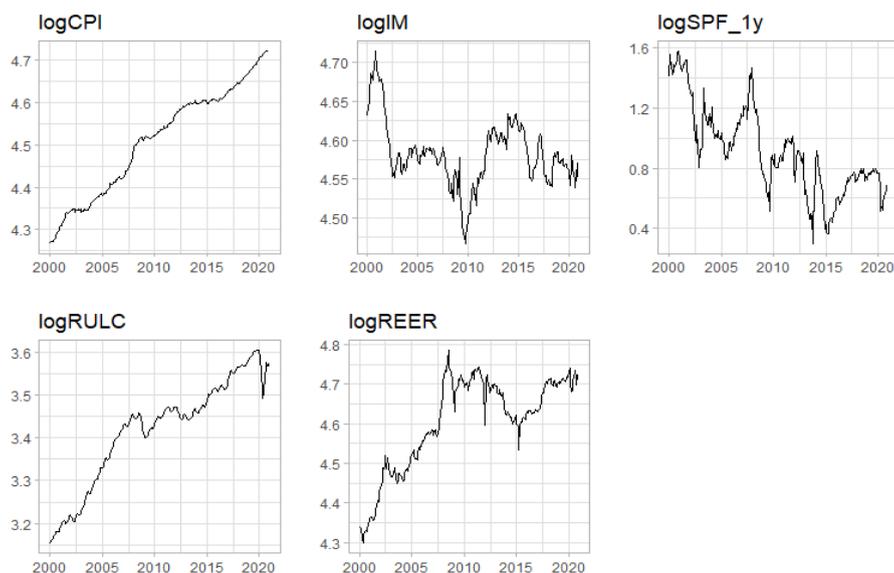


Fig. 17. Selected monthly time series for the Czech Republic, 2000-2020

Source: Authors' elaboration based on the ARAD and CZSO data.

Macroeconomic time series tend to be non-stationary, what can be seen also in Table 1., comparing two statistical tests for stationarity, Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test.⁴ One way to make non-

⁴ There is one technical difference between the two. ADF test uses H_0 : “the series has a unit root”, while KPSS formulates H_0 : “the process is trend stationary”. Thereby, in case of the ADF test rejecting the null hypothesis means that the time series is

stationary data stationary is to correct them by differencing.⁵ Employing the `ndiffs` function from the R “forecast” package, we estimate the number of differences needed for the non-stationary time series, and we run the tests again. The unit root tests in column (3) and (4) show us that non-stationarity subsequently disappears with the time series integrated of order 1.

Table 27. Unit-Root ADF and KPSS Tests

	ADF (1)	KPSS (2)	ADF_{diff} (3)	KPSS_{diff} (4)
<i>logCPI</i>	0.6179	0.01	0.01**	0.1**
<i>logIM</i>	0.4379	0.0201	0.01**	0.1**
<i>logSPF_1Y</i>	0.0625	0.01	0.01**	0.1**
<i>logRULC</i>	0.6305	0.01	0.01**	0.1**
<i>logREER</i>	0.6267	0.1**	0.01**	0.1**

Note: ** stationary at 5% significance level. Test equations include both intercept and trend. Incorporation `adf.test` and `kpss.test` function in “tstimes” R package.

Source: Authors’ elaboration based on the ARAD and CZSO data.

Since the variables are stationary of order 1, that is $\{Y_{CPI}, X_{SPF}, X_{RULC}, X_{REER}, X_{IM}\} \sim I(1)$, we test for coordination vectors between them based on Johansen & Juselius (1990). Running Johansen’s cointegration test (Table 2.), the trace and maximum eigenvalue type demonstrate that there is one cointegration relationships at 5% critical value and there exist a long-term relationship between the variables .

Table 2. Johansen’s Cointegration Test

Rank	λ_{Trace}	5% value	$\lambda_{Max Eigen}$	5% value
$r \leq 4$	7.72	9.24	7.72	9.24
$r \leq 3$	16.34	19.96	8.62	15.67
$r \leq 2$	27.60	34.91	11.26	22.00
$r \leq 1$	51.63	53.12	24.03	28.14
$r = 0$	113.14	76.07	61.51	34.40

Note: Using `VARselect` command, 5 lags chosen as the optimal lag based on AIC (Akaike information criterion) minus 1. For the cointegration test, `ca.jo()` command is used from “urca” R package.

Source: Authors’ elaboration based on the ARAD and CZSO data.

stationary, while in case of the KPSS rejecting the null hypothesis means that the time series is non-stationary.

⁵ Differencing can help stabilize the mean of a time series by removing changes in the level of a time series. A single difference means $\Delta X_t = X_t - X_{t-1}$.

3.2 Methodology

Since the time series are multivariate - I(1) - and there exists a cointegration relationship between them ($\hat{u}_t \sim I(0)$), we can dutifully avoid spurious regression by applying constructing an *Error Correction Model* (ECM). The general form of an ECM is:

$$\Delta Y_t = \alpha_0 + \beta_1 \Delta X_{1,t} + \dots + \beta_i \Delta X_{i,t} + \pi \hat{u}_{t-1} + e_t \quad (4)$$

The ECM includes both short-run and long-run information Shrestha & Bhatta (2018). The β_1 represents short-run effect measuring the immediate impact a change in $X_{i,t}$ will have on a change in Y_t . On the other hand, π is the feedback effect, showing how quickly does the dependent variable return to the equilibrium once it oscillated. Lastly, \hat{u}_{t-1} measures the long-run response. We run the ECM based on the hybrid NKPC from the equation (3).

Additionally, we compare these results with the simple *Autoregressive Distributed Lag* (ARDL) model using the first difference of the non-stationary variables, as we have showed in the Table 1. that all the variables are integrated in order I(1).⁶ The simple differenced ARDL model describing the behavior of Y in terms of variables X_i be considered as follows:

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta Y_{t-2} + \dots + \gamma_0 \Delta X_{i,t-1} + \gamma_1 \Delta X_{i,t-2} + u_t \quad (5)$$

where $u_t \sim iid(0, \sigma^2)$; γ denotes short run reaction of Y_t to changes in $X_{i,t}$.

4 Results

ECM and ARDL models trying to estimate the short-run relationship between inflation and real unit labor costs in the Czech Republic during the period 2000M1-2020M12 are depicted in the Table 3. Running the unit-root ADF and KPSS tests as well as the Johansen's cointegration test proved useful in rejecting utilization of models based on *ax ante* stationary data. Taking a look at column (iii) in Table 3., non-stationary data with simple ARDL in levels create *spurious* regression results falsely indicating strong relationship between lagged logCPI, logged expected inflation and logged real labor unit costs on the short-term development of inflation, as described by the general equation (3). Interestingly, neither the lagged import prices, nor the lagged real effective exchange rate have an impact on the inflation development in the spurious ARDL, as suggested by Milučká (2014). These two variables, according to the ECM (i) model, seem to influence the inflation only in the short-run, and even then, only in lagged and differenced form.

Turning our attention on the ECM (i) and ARDL in differences (ii) model, we can immediately notice that both models generate very low multiple R^2 . Comparing the two models, the ECM indicates longer-term statistical significance of the lagged

⁶ The first order differencing might remove certain aspects in the educational information from the data.

logSPF_1y, our proxy for the expected inflation, and lagged log RULC, the proxy we choose to employ instead of the real marginal costs. The inflation expectations are statistically significant also in the ARDL model, in its differenced form, when getting rid of the non-stationarity. Differenced RULC, the key concept of the NKPC, on the other hand, does not seem to be plausible in neither of the two models.

Table 3. ECM and ARDL results of the hybrid NKPC in the Czech Republic

	ECM (i)	ARDL in differences (ii)	ARDL in levels (iii)
<i>(Intercept)</i>	-0.045 (0.036)	-0.025* (0.012)	-0.029 (0.037)
<i>logCPI_{t-1}</i>	-0.004 (0.006)	-	0.994*** (0.006)
<i>logSPF_1y_t</i>	-	0.005*** (0.001)	0.004*** (0.001)
<i>logSPF_1y_{t-1}</i>	0.005*** (0.001)	-	-
<i>logRULC_{t-1}</i>	0.0144** (0.005)	-	-
<i>logRULC_t</i>	-	0.019** (0.005)	0.015** (0.005)
<i>logIM_{t-1}</i>	-	-	0.002 (0.007)
<i>logREER_{t-1}</i>	-	-	-0.003 (0.004)
<i>logIM_{t-2}</i>	0.005 (0.007)	-	-
<i>logREER_{t-2}</i>	-0.002 (0.004)	-	-
<i>ΔlogCPI_{t-1}</i>	-	0.058 (0.066)	-
<i>ΔlogSPF_1y_t</i>	-0.005* (0.002)	-0.001*** (0.003)	-
<i>ΔlogRULC_t</i>	0.024 (0.027)	0.019 (0.028)	-
<i>ΔlogIM_{t-1}</i>	0.095*** (0.022)	0.016 (0.023)	-
<i>Δlog REER_{t-1}</i>	0.049*** (0.013)	0.003 (0.013)	-
<i>Observations</i>	242	241	245
<i>R²</i>	0.263	0.177	0.9995

Note: *, **, *** indicates significance at the 90%, 95%, and 99% level, respectively. Standard errors in parentheses. ECM model built using *ecm* function from the “*ecm*” R package, ARDL *dynardl* function from the “*dynamic*” R package.

Source: Authors' elaboration based on the ARAD and CZSO data.

As was already mentioned, the ECM model assigns short-term significance to the differenced and lagged REER and import prices, and to a lesser extent differenced expected inflation as well. Subsequently, only the lagged expected inflation and lagged RULC prevail in the longer run in terms of their impact on the inflation. The case of the ARDL in differences, model with variables integrated in order $I(1)$, empirically supports the expected inflation as a driver of inflation, although not the RULC. Also, neither the lagged REER and import prices are significant in the ARDL model with differences. The REER is overall surprisingly unimpactful, in all three models. The reason behind this might be that it was not until the November 2013, when the Czech National Bank (CNB) decided to introduce a one-sided floor on the exchange rate as an additional monetary policy instrument. However, it was not until the August 2015 the CNB starts pursuing continuous foreign exchange interventions policy. Therefore, even if Caselli (2017) argues that the CNB was relatively successful in fighting deflationary pressures via the real exchange rate, the period between the second half of 2015 and the end of 2020 is relatively short to influence the results, although the ECM indicates something.

Another paradox is that none of the models, when omitting the spurious ARDL regression, provides evidence for backward-looking inflation behavior, as suggested by the *hybrid* NKPC. We can carefully conclude that there is an indication that the expected inflation and RULC might have an impact on the inflation when employing the ECM and ARDL_{Diff} for the Czech Republic between 2000M1 and 2020M12, although the results are too weak to be unambiguous and conclusive, especially in the case of labor unit costs.

5 Concluding Remarks

Implicitly agreeing with Arlt & Plašil (2005), we conclude that results from the hybrid NKFC for the Czech Republic between 2000M1 and 2020M12 are utmost ambiguous. Examining the trade-off between inflation on the one hand; and inflation expectations, labor unit costs, import prices and the real effective exchange rate on the other, we found out that results from the ECM and differenced ARDL models trying to deal with non-stationary and cointegrated time series integrated in of order $I(1)$ are inconclusive. The ECM model indicates that in the shorter-run, only lagged import prices, the lagged REER and to a lesser extend inflation expectations influence the inflation, while in the longer-run, the lagged seasonally adjusted real unit labor cost (RULC) and the lagged inflation expectations for one-year horizon prevail. The ARDL model with first order differencing provides evidence only for the expected inflation. The RULC and non-differenced inflation expectations seem to generate a spurious regression results. Paradoxically, none of the models give weight to the lagged inflation, as a proxy for backward-looking price setting, despite being one of the cornerstones of the *hybrid* NKPC models.

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The Fractional-Order Goodwin Accelerator Model

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Abstract. The accelerator model proposed by Goodwin in 1951 is one of the pioneering nonlinear mathematical models of the business cycle. It has been studied in three different mathematical formulations, namely as a first-order delay differential equation, as a second-order ordinary differential equation and as a dynamical system of two first-order ordinary differential equations. All these formulations exhibit chaotic behavior. In this article, we analyze a fractional-order dynamical system of a specific form of the generalized dynamical system originating from the Goodwin accelerator model. We examine the steady-state stability of the commensurate as well as the incommensurate nonperturbed system. Subsequently, a numerical analysis of both the perturbed and the nonperturbed fractional-order system is conducted. Our main finding is that the incorporation of memory (or expectations) in the model can lead to local asymptotic stability of its equilibria and to less chaotic behavior. This can prove beneficial in modeling economic phenomena which are heavily dependent upon their past states.

Keywords: Fractional-Order Dynamical Systems, Accelerator-Multiplier Models, Economic Modeling

JEL classification: C61, C62, E32

1 Introduction

Mathematical methods have permeated mainstream economics since the Second World War. One of the very first areas of economic research to have been affected by the implementation of mathematics in economics is the study of business cycles. Frisch (1933) proposes one of the pioneering mathematical models of the business cycle, which is based upon the idea of the accelerator and the multiplier. It is formulated as a

linear model. On the one hand, this rather simple mathematical structure makes it analytically solvable, but on the other hand it negatively impacts its ability to represent economic phenomena realistically¹. As it turns out, linear models (albeit a powerful tool in mathematical modeling) generally fail to capture most of complexity of the real world. Goodwin (1951) tries to remedy this drawback of the previously-considered accelerator-multiplier models by deriving a model of his own². Not only is this model nonlinear, which brings about some very interesting and chaotic behavior, but Goodwin also takes into account disinvestment and a time lag between decisions about investment and the corresponding outlays. These alterations make the model more realistic than its predecessors, though at the cost of greater mathematical complexity.

Despite all of the aforementioned efforts to make business-cycle modeling more realistic, one major aspect of economic phenomena is still largely overlooked when integer-order calculus is utilized. Economic systems possess a “memory” - i.e., they depend not only upon their current state (and its change in time), but they are highly influenced by their past states as well. This is the very reason why fractional-order calculus may prove beneficial when modeling real-world natural, technical as well as socioeconomic processes.

The main objective of this article is, therefore, to analyze the steady-state stability of the fractional-order Goodwin dynamical system of a specific form introduced in the text. In Section 2 the most relevant literature is discussed. In Section 3 methodology of which we make use throughout the article is briefly explained. We present the main results of our qualitative as well as numerical analysis in Section 4 and 5. Conclusions are drawn from the results and prospects for further research are considered in Section 6.

2 Literature Review

Goodwin (1951) presents a series of nonlinear dynamical business-cycle models with increasing mathematical complexity, which he hopes can better depict real-world economic processes than linear models proposed earlier. He eventually arrives at a first-order nonlinear delay differential equation (DDE; see Eqn. (4.1)). He then eliminates the delays by means of the Taylor series expansion. This gives rise to at least three different mathematical representations (all of which are laid out in Section 4) of the model. Goodwin (1951) analyzes qualitative properties of a second-order nonlinear ordinary differential equation (ODE; see Eqn. (4.2)) which arises by eliminating delays in the original DDE.

¹ It must be mentioned, however, that Frisch introduced random shocks in the investment equation, which prevent oscillations from dying down on their own, and thus the economy from gradually settling down into its equilibrium. This can be viewed as an attempt at employing stochastic modeling in economics.

² Not to be confused with another well-known model invented by Goodwin, namely the Goodwin model of the class struggle, which is usually referred to as the Goodwin Model.

The original representation as a DDE is scrutinized by Matsumoto, Merlone and Szidarovszky (2018). They investigate the link between delay values and the existence of a limit cycle in the model. Fractional-order formulations of this DDE (as well as a slightly extended version thereof) are studied by Lin et al. (2020).

The last possible formulation of the Goodwin accelerator model is in the form of a dynamical system of first-order differential equations (see Eqn. (4.5)). A general version of this system is proposed by Lorenz (1987), whereas a particular form, which is studied in this article, appears in Lorenz and Nusse (2002). The integer-order version of this system is analyzed in detail by Li et al. (2011). A numerical analysis of a similar model is conducted by He, Yi and Tang (2016).

3 Methodology

In this section we define some of the most important concepts of fractional calculus and state stability theorems which we apply in the next section. Even though we mention three different definitions of fractional-order derivatives, our qualitative analysis is general and does not hinge upon a particular definition. Nevertheless, the presented numerical method, which is used to simulate the system trajectories, is based upon the Grünwald-Letnikov definition. Since the three definitions are equivalent for a wide range of functions, this numerical method generally provides fairly satisfactory approximations³. All the definitions and theorems mentioned here can be studied further in Petras (2011) or Podlubny (1999). Let us first define the *differintegral*:

$${}_a D_t^\alpha = \begin{cases} \frac{d^\alpha}{dt^\alpha}; & \alpha > 0 \\ 1; & \alpha = 0 \\ \int_a^t (d\tau)^\alpha; & \alpha < 0 \end{cases} \quad (3.1)$$

An important special function used in fractional calculus is the (Euler's) *gamma function* defined as follows:

$$\Gamma(x) = \int_0^\infty t^{x-1} e^{-t} dt \quad (3.2)$$

³ Nonetheless, extra vigilance is definitely in place when dealing with chaotic fractional-order systems numerically owing to the fact that fractional-order numerical methods are not as developed as their integer-order counterparts just yet (one ought to treat integer-order chaotic systems with the utmost care as well), and seemingly insignificant changes in initial conditions and/or parameters of chaotic systems may have drastic consequences for the system trajectories. Some issues with numerical simulations of chaotic (or even stiff) systems could be partially avoided by taking an extremely small step size, which would, however, increase the computational complexity considerably. Therefore, numerical simulations presented (not only) in this article should be regarded merely as crude depictions of the system trajectories.

The Grünwald-Letnikov, Riemann-Liouville and Caputo derivatives are defined in the following fashion, respectively:

$${}^G\!D_t^\alpha f(t) = \lim_{h \rightarrow 0} \frac{1}{h^\alpha} \sum_{j=0}^{\lfloor \frac{t-a}{h} \rfloor} (-1)^j \frac{\Gamma(\alpha + 1)}{\Gamma(j + 1)\Gamma(\alpha - j + 1)} f(t - jh) \tag{3.3}$$

$${}^R\!D_t^\alpha f(t) = \frac{1}{\Gamma(n - \alpha)} \frac{d^n}{dt^n} \int_a^t \frac{f(\tau)}{(t - \tau)^{\alpha - n + 1}} d\tau; \quad n - 1 < \alpha < n \tag{3.4}$$

$${}^C\!D_t^\alpha f(t) = \frac{1}{\Gamma(n - \alpha)} \int_a^t \frac{f^{(n)}(\tau)}{(t - \tau)^{\alpha - n + 1}} d\tau; \quad n - 1 < \alpha < n \tag{3.5}$$

Let us now consider the following fractional-order differential equation:

$${}_aD_t^\alpha y(t) = f(y(t), t) \tag{3.6}$$

Based upon the Grünwald-Letnikov definition, we can approximate its solutions numerically:

$$y(t_k) = f(y(t_k), t_k)h^\alpha - \sum_{i=v}^k c_i^{(\alpha)} y(t_{k-i}) \tag{3.7}$$

where:

$$c_0^{(\alpha)} = 1; \quad c_i^{(\alpha)} = \left(1 - \frac{1 + \alpha}{i}\right) c_{i-1}^{(\alpha)} \tag{3.8}$$

Let us look at a *fractional-order dynamical system* (bold denotes vectors and matrices):

$$D^\alpha \mathbf{x} = \mathbf{f}(\mathbf{x}) \tag{3.9}$$

We say that \mathbf{x}^* is an *equilibrium (steady state)* of (3.9) iff⁴:

$$\mathbf{f}(\mathbf{x}^*) = \mathbf{0} \tag{3.10}$$

Theorem 1: An equilibrium of a commensurate⁵ fractional-order nonlinear dynamical system is locally asymptotically stable if all eigenvalues of the Jacobian matrix of the system evaluated at the equilibrium satisfy the following condition (if they lie in the stable region of the complex plane):

$$|\arg(\text{eig}(\mathbf{J}))| = |\arg(\lambda_i)| > \alpha \frac{\pi}{2} \tag{3.11}$$

Theorem 2: An equilibrium of an incommensurate⁶ fractional-order nonlinear dynamical system is locally asymptotically stable if all roots of Equation (3.12) satisfy the condition in Equation (3.13):

$$\det(\text{diag}(\lambda^{\text{lcm}(q_1, \dots, q_n)\alpha_1}, \dots, \lambda^{\text{lcm}(q_1, \dots, q_n)\alpha_n}) - \mathbf{J}) = 0 \tag{3.12}$$

$$|\arg(\lambda)| > \frac{1}{\text{lcm}(q_1, \dots, q_n)} \frac{\pi}{2} \tag{3.13}$$

where $\alpha_i := \frac{p_i}{q_i}$ is the derivative order of the *i*th equation and *lcm* denotes the least common multiple.

An equilibrium is called a *saddle point* if at least one eigenvalue lies in the stable region and at least one in the unstable region.

⁴ if and only if

⁵ Which means that all derivative orders are equal.

⁶ Which means that not all derivative orders are equal.

4 Stability Analysis of the Model

Goodwin (1951) proposes the following delay differential equation (DDE) to model the multiplier-accelerator interaction in the economy:

$$\varepsilon \frac{dx(t+\theta)}{dt} + (1-\alpha)x(t+\theta) = O_A(t+\theta) + \varphi\left(\frac{dx(t)}{dt}\right) \quad (4.1)$$

Approximating the delayed terms linearly using their respective Taylor series expansions and shifting $O_A(t+\theta)$ by θ units in time, he arrives at the following second-order nonlinear ordinary differential equation:

$$\varepsilon \frac{d^2x(t)}{dt^2} + (\varepsilon + (1-\alpha)\theta) \frac{dx(t)}{dt} - \varphi\left(\frac{dx(t)}{dt}\right) + (1-\alpha)x(t) = O^*(t) \quad (4.2)$$

It ought to be noted here that Eqn. (4.2) does not necessarily exhibit the same properties as Eqn. (4.1). Therefore, it is advisable that numerical simulations of the solution to the original DDE be carried out to inspect whether dropping higher-order terms in the Taylor series may have caused any significant changes in the qualitative properties of the model. That said, it was not until a few decades after the model had first been published that a vast majority of contemporary numerical methods which are capable of efficiently and effectively approximating solutions to DDEs became widely available. Moreover, advanced analytical techniques which are nowadays utilized for closely examining DDEs had yet to be introduced as well.

Lorenz (1987) generalizes Eqn. (4.2) in the following manner:

$$\frac{d^2x(t)}{dt^2} + A(x(t)) \frac{dx(t)}{dt} + B(x(t)) = O^*(t) \quad (4.3)$$

where $A(x(t))$ is an even function such that $A(0) < 0$, $B(x(t))$ is an odd function with $B(0) = 0$. We are particularly interested in a specific form of this generalization considered by Lorenz and Nusse (2002):

$$\frac{d^2x(t)}{dt^2} + \alpha \frac{x^2(t) - 1}{x^2(t) + 1} \frac{dx(t)}{dt} - \omega_0 x(t) + \delta x^3(t) = f \sin(\Omega_1 t) \quad (4.4)$$

As is shown in Li et al. (2011), Eqn. (4.4) can be rewritten as the following dynamical system:

$$\begin{aligned} \frac{dx(t)}{dt} &= y(t) \\ \frac{dy(t)}{dt} &= -\alpha \frac{x^2(t) - 1}{x^2(t) + 1} y(t) + \omega_0 x(t) - \delta x^3(t) + f \sin(\Omega_1 t) \end{aligned} \quad (4.5)$$

In this article we consider a generalized version of Eqn. (4.5):

$$\begin{aligned} {}_0D_t^{q_1} x(t) &= y(t) \\ {}_0D_t^{q_2} y(t) &= -\alpha \frac{x^2(t) - 1}{x^2(t) + 1} y(t) + \omega_0 x(t) - \delta x^3(t) + f \sin(\Omega_1 t) \end{aligned} \quad (4.6)$$

where $\alpha := \varepsilon \tilde{\alpha}$, $f := \varepsilon \tilde{f}$, ω_0 , δ and Ω_1 are parameters of the model and $\varepsilon \geq 0$ is a perturbation parameter. Parameters q_1 and q_2 denote derivative orders and are assumed to be positive rational numbers less than 2. Although parameters α and ω_0 are assumed positive, which stems from the aforementioned conditions imposed upon functions

$A(x(t))$ and $B(x(t))$ from Eqn. (4.3), we do not restrict them to being positive in our analysis. But at the same time in order to ensure analytical tractability, we only analyze the steady-state stability of the nonperturbed version of Eqn. (4.6), i.e., we assume $\varepsilon = 0$. The perturbed version, which is described in Eqn. (4.6), is subsequently analyzed numerically.

4.1 Equilibria of the Nonperturbed System

In order to obtain equilibria of the nonperturbed version of Eqn. (4.6), one needs to solve the following nonlinear system of algebraic equations:

$$0 = y_e \quad (4.7)$$

$$0 = \omega_0 x_e - \delta x_e^3$$

In case parameters ω_0 and δ are non-zero with the same sign, there are three distinct equilibria⁷, namely $(0, 0)$, $(\pm\sqrt{\frac{\omega_0}{\delta}}, 0)$. If either parameter (but not both) is equal to zero, or if the parameters have opposite signs, only one distinct equilibrium exists - $(0, 0)$. Should both parameters be zero at the same time, then there would be infinitely many equilibrium points with coordinates $(c, 0)$; $c \in \mathbb{R}$. All eigenvalues are then, however, zero so we omit this case in our analysis altogether. The same is true when $\omega_0 = 0$ so we do not analyze this case here, either.

4.2 Steady-State Stability of the Commensurate Nonperturbed System

The first step of the analysis is to evaluate the Jacobian matrix at each steady state. For the nonperturbed system it has the following form:

$$J = \begin{pmatrix} 0 & 1 \\ \omega_0 - 3\delta x_e^2 & 0 \end{pmatrix} \quad (4.8)$$

(1) Let us first investigate $(0, 0)$. The characteristic equation for this equilibrium is:

$$\lambda^2 - \omega_0 = 0 \quad (4.9)$$

If $\omega_0 > 0$, then the corresponding eigenvalues are $\lambda_{1,2} = \pm\sqrt{\omega_0}$. Hence, the equilibrium is a saddle point for the derivative orders considered in this article. If $\omega_0 < 0$, the eigenvalues become $\lambda_{1,2} = \pm\sqrt{\omega_0}i$. Hence, if the derivative order is less than 1, the equilibrium is locally asymptotically stable according to Theorem 1. Since $tr(J) = 0$ and $det(J) > 0$, the equilibrium becomes a stable center when the derivative order is 1. For higher orders, both eigenvalues lie in the unstable region.

(2) Since the equilibrium point in the Jacobian matrix is raised to the second power, we can analyze both equilibrium points $(\pm\sqrt{\frac{\omega_0}{\delta}}, 0)$ simultaneously. The characteristic equation in this case becomes:

$$\lambda^2 + 2\omega_0 = 0 \quad (4.10)$$

⁷ Here, the abscissa represents x_e and the ordinate represents y_e .

with eigenvalues either $\lambda_{1,2} = \pm\sqrt{-2\omega_0}$ if $\omega_0 < 0$ or $\lambda_{1,2} = \pm\sqrt{-2\omega_0}i$ if $\omega_0 > 0$. In the first case, the equilibria are saddle points. In the second case, the equilibria are asymptotically stable if the derivative order is less than 1. When it is identically one, the equilibria are stable centers. In case of higher orders, the eigenvalues lie in the unstable region so chaotic behavior can potentially occur.

4.3 Steady-State Stability of the Incommensurate Nonperturbed System

(1) Let us start by analyzing $(0, 0)$. The corresponding characteristic equation for the incommensurate system is as follows:

$$\lambda^{M(q_1+q_2)} - \omega_0 = 0 \quad (4.11)$$

where M is the least common multiple⁸ discussed in Theorem 2. There are exactly $M(q_1 + q_2)$ complex solutions to this equation, which is a direct corollary of the well-known fundamental theorem of algebra. In order to establish stability conditions, their respective arguments need to be analyzed.

Let us first assume that $\omega_0 > 0$. It follows from the de Moivre's formula that their respective arguments are of the form⁹ $\frac{2\pi k}{M(q_1+q_2)}$; $k = 0, 1, \dots, M(q_1 + q_2) - 1$. One can immediately notice that for $k = 0$, the solution lies in the unstable region for all derivative orders considered in the article. Let us then derive a condition for which the equilibrium is a saddle point. Since one root of the equation is always guaranteed to lie in the unstable region, we now seek to ensure that at least one root be in the stable region. That entails putting a constraint upon $q_1 + q_2$ so that $\frac{2k\pi}{M(q_1+q_2)} > \frac{\pi}{2M}$ and $\frac{2k\pi}{M(q_1+q_2)} < 2\pi - \frac{\pi}{2M}$ for the same k ¹⁰. It can be verified directly using simple algebraic techniques that the k th root lies in the stable region if¹¹ $\frac{4k}{4M-1} < q_1 + q_2 < 4k$.

If $\omega_0 < 0$, the corresponding arguments are of the form $\frac{\pi+2\pi k}{M(q_1+q_2)}$; $k = 0, 1, \dots, M(q_1 + q_2) - 1$. It can be derived applying the same reasoning as above that the k th root lies in the stable region if $\frac{4k+2}{4M-1} < q_1 + q_2 < 4k + 2$. It is locally asymptotically stable if all roots lie in the stable region, which is ensured when $\frac{2}{4M-1} < q_1 + q_2 < 2$.

(2) The characteristic equation for $(\pm\sqrt{\frac{\omega_0}{\delta}}, 0)$ is:

$$\lambda^{M(q_1+q_2)} + 2\omega_0 = 0 \quad (4.12)$$

The constant term of the polynomial is nearly identical to the one in Eqn. (4.11), except for the fact that it has the opposite sign and twice the modulus. Hence, the solutions to

⁸ More precisely, it is a natural number associated with the least common multiple.

⁹ Since $M(q_1 + q_2) \geq 2$ and the characteristic polynomial only has the leading coefficient and the constant term, there are always at least 2 distinct roots.

¹⁰ Where $k = 1, \dots, M(q_1 + q_2) - 1$.

¹¹ Since $M \geq 2$, $\frac{4k}{4M-1} \leq \frac{4k}{7}$. This upper bound is useful for $k = 1$. The other fraction containing M is practical for $k = M(q_1 + q_2) - n$; $n = 1, \dots, M(q_1 + q_2) - 2$.

Eqn. (4.11) for $\omega_0 < 0$ have the same arguments as those to Eqn. (4.12) for $\omega_0 > 0$ and vice versa. Therefore, conclusions concerning stability of these two equilibria are essentially the same as in the previous case; the only difference being that they apply to ω_0 with the opposite sign.

5 Numerical Analysis of the Model

In this section, we present numerical simulations of the nonperturbed as well as the perturbed version of the system described in Eqn. (4.6) based upon a numerical technique explained in Section 3. For this purpose, we have programmed a MATLAB function with the help of a toolbox published by Petras (2021). The colors pertain to specific derivative orders: blue to [1, 1], red to [0.95, 0.95], green to [0.9, 0.9] and yellow to [1, 0.9].

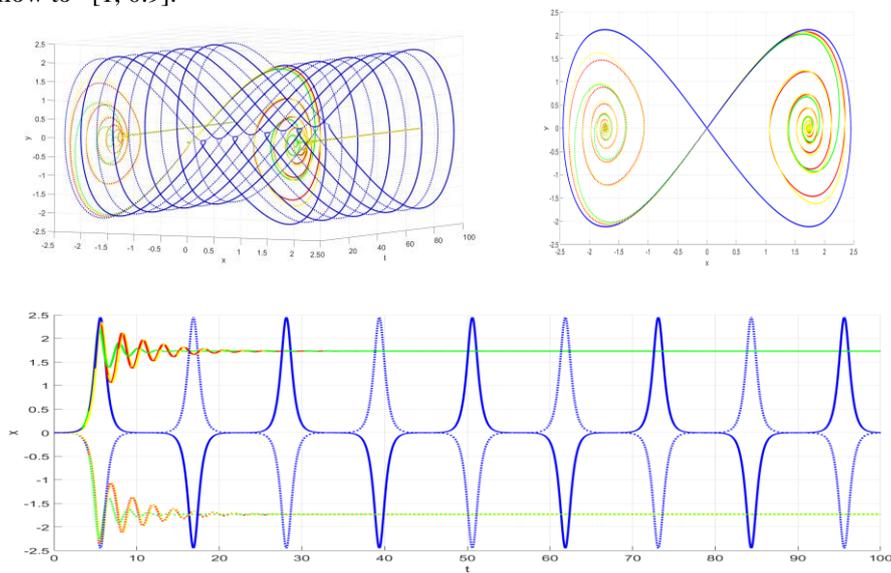


Fig. 1. Numerical simulations of the nonperturbed system with parameter values $\delta = 1$, $\omega_0 = 3$. Solid and dotted lines represent the following initial conditions - $[0, 0.001]$, $[0, -0.001]$. The left picture depicts selected trajectories in the x - t - y plane while the right one in the x - y plane. In the bottom picture, the evolution of x in time is depicted.

As shown in Fig. 1., incorporation of memory in the model by means of fractional calculus can bring stability to the system. In the integer-order case for the selected parameters and initial conditions, a homoclinic orbit can be observed. The system oscillates around its two non-zero equilibria (which are stable centers), joining the zero equilibrium (which is a saddle point) to itself. If we decrease the derivative orders (so that the conditions for local asymptotic stability derived in the previous section are

satisfied), the two non-zero equilibria become stable foci¹² - trajectories starting nearby spiral towards them in time.

Fig. 2. depicts a perturbed version of the system. The system appears to behave chaotically for integer orders. Lowering the derivative orders causes the system trajectories to oscillate around one of the non-zero equilibria in a somewhat regular fashion. Once again, certain fractional orders have turned a rather chaotic system into a relatively stable one.

Similar observations could be made for other initial conditions and parameters as well. Carefully-chosen fractional orders can sometimes bring stability to otherwise chaotic systems.

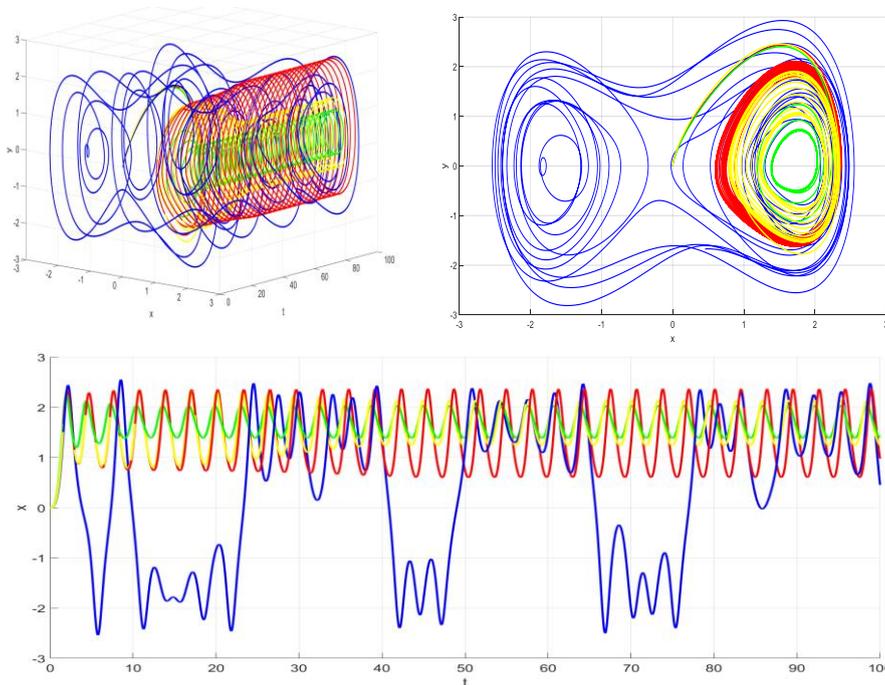


Fig. 2. Numerical simulations of the perturbed system with parameter values $\delta = 1$, $\omega_0 = 3$, $\alpha = 0.5$, $f = 0.95$, $\Omega_1 = 2$ and the initial condition $[0, 0.001]$. The left picture depicts selected trajectories in the x - t - y plane while the right one in the x - y plane. In the bottom picture, the evolution of x in time is depicted.

¹² Sometimes called focus points or spiral points.

6 Conclusion

As has been shown in this article, fractional calculus can effectively turn unstable or neutrally stable equilibria into locally asymptotically stable ones. This incorporation of memory (or a certain kind of backward-looking expectations if you will) may cause chaotic systems to behave relatively predictably. Not only do nearly all economic processes depend upon their past states and expectations, but there is also another argument¹³ to consider, which favors using fractional calculus in economics more extensively. Economic phenomena are usually very complex. Even highly simplified mathematical formulations thereof can lead to chaotic models, in which a subtle change in parameters and/or initial conditions can turn a stable, equilibrium-approaching system into a system which blows up. However, these blow-ups do not reflect what can be observed in the real world whatsoever. Even though economic processes can evolve in an oscillatory behavior and abrupt shifts can be detected therein, rarely (if ever at all) do we see them violently spiral out of their way and never come back, just because a parameter or an initial condition has slightly changed¹⁴. If this were the case, we might just be lucky to have been born into a world with stable parameters and initial conditions. It is much more likely that our world, however complex it may be, is structurally more stable than its mathematical depiction with integer-order dynamical systems, and the observed oscillations and sudden changes may just be a result of perturbations affecting the system.

This article does not purport to substantiate this claim. It only provides evidence that fractional-order derivatives may have a significant impact upon the steady-state stability of dynamical systems. Therefore, if economists aim to model a system which greatly depends upon its past states, fractional calculus might be an invaluable tool in their mathematical toolkit.

¹³ The main idea behind this argument was put forth by Martin Šuster, the director of economic research at the National Bank of Slovakia, when the author of this article was discussing economic modeling with him.

¹⁴ In some cases, one might argue that a small change in a specific parameter can lead to major changes, after all. For instance, the (entirely for some) different paths upon which West and East Germany or South and North Korea embarked after they had split up and different political and economic ideologies had been adopted. The question is, however, whether these changes were actually subtle (as changes can impact system trajectories significantly even in otherwise stable fractional-order systems, as is shown in our analysis as well when ω_0 changes signs). Even if that was indeed the case, both systems despite the change in parameters might still have been converging to the very same mutual equilibrium. The convergence may just have been expedited (or impeded, for that matter).

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Impact of electronic auctions on business procurement in Slovakia during COVID-19

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Abstract. Purchasing processes are involved in large scale innovation opportunities. These innovations will determine future of business procurement. We summarized modern and innovative methods of today's procurement and analyzed impact of electronic auctions on cost avoidance and cost savings, during COVID-19 pandemics and pre-pandemic state. According to our findings, there are several innovative methods of modern procurement such as electronic auctions, online contracting, claim management e.g. Further more, electronic auctions significantly improve cost avoidance opportunities for businesses. Use of electronic auctions was enhanced during pandemic of COVID-19.

Keywords: e-procurement, purchasing, electronic auctions

JEL classification: *M15, M29*

1 Business e-procurement

Purchasing can be understood as the activity of businesses or individuals, with a view to acquiring new goods or services for a specified consideration, at a certain time and quantity, and under agreed conditions. A key aspect of buying companies is the provision of the desired goods or services, at the required time, to the desired place, in the required quality and quantity (1).

If such purchasing operations are carried out using or solely done by means of electronic and information devices, we are talking about electronic procurement (e-procurement). Purchase from a system point of view, we rank among the basic activities of production as well as companies. From the point of view of the production companies, the purchase is the first within the chain of purchase, production, sale. In companies selling services, the chain is simpler and excludes production activities (1). The European Commission characterises e-Procurement as a general term for the transition from classic "paper" processes to electronic process solutions in purchasing systems (2).

According to Pratt, we can characterize E-procurement or electronic purchasing as the process of queuing, ordering and purchasing in the B2B segment, using electronic devices and internet services (3).

Such a process is provided by e-procurement software that is adapted for the activities. We know several forms of electronic purchasing in companies (4):

I. RFI (request for information) tools- online tools and software services in order to obtain information about suppliers as well as information from suppliers for required purchase projects.

II. RFP (request for proposal) tools– these are online tools providing first revaluations or feasibility analyses with given suppliers, via the Internet or 3D virtual inspections.

III. FPQ (request for quotation) tools – ensure online revaluation or inquiries of suppliers.

IV. Tendering tools – a set of tools thanks to which buyers carry out tendering procedures of suppliers and dealings. These include, for example, electronic auction portals or online communication software.

V. Electronic catalogues - these are tools thanks to which the company is able to implement external catalogues into the internal system. Thanks to this, individual employees can directly purchase goods and services at pre-arranged prices, themselves and without the support of the purchasing department.

VI. Automatic purchasing systems – it is a set of systems that, under predetermined conditions, automatically purchase certain goods or services. Such a system can be imagined on the automation of material purchase, when the internal system detects a lack of certain items in stock, on the basis of which it automatically generates and sends an order.

In addition to these systems, separate electronic purchasing systems for logistics, warehousing and control, such as:

I. Stock Solutions - This is a toolkit where employees gain access to their suppliers' stock information, so they can order the required items in the required quantities.

II. Electronic audits, self-assessments and control of suppliers – tools through which the system automatically invites the supplier for self-assessment, the supplier fills in the required information and records the required documents, on the basis of which self-assessment is automatically evaluated and corrective measures are taken, etc. This is specifically useful in terms of ongoing COVID-19 pandemics.

III. Autonomous warehouse systems- these are now well known in bigger companies or logistics firms. In advance, new innovative methods of stock management are used such as GPS location of specific parts and so on.

We have to mention, that digitization of business procurement processes is enhanced also by the fact of ongoing pandemics of COVID-19, due to which management of companies needs to prevent personal contact of employees. This increases need for internet and cloud based solutions for large scale business procurement processes including tendering, negotiating, logistics, and so on.

E-procurement systems can take different forms in terms of automating the sub-processes that individual subsystems operate, especially (5):

- a) Automated systems - most or all partial processes are implemented by the system automatically, without the need for user intervention. These include, for example, automated purchases of spare parts in case the system detects a shortage of spare parts in stock. These are very useful, modern and efficient tools that allow the enterprise to respond quickly and perform simple as well as complex operations based on system instructions.
- b) Combined systems - it is a penetration of automated and non-automated systems, when system user intervention, data import and so on are needed. However, manual intervention induces or, conversely, terminates the system process, which is also automated. These are, for example, electronic auction systems commissioned by the responsible purchaser, but their actual execution as well as evaluation are further automatic.

Mostly, complex e-procurement systems are already programmed and companies are able to buy a licenses for most of needed solutions. In case there are specific needs of companies for specific procurement processes, they have to program it or buy solution from an authorized IT company.

1.1 Electronic auctions in business procurement

In the business as well as in private spheres, the first electronic auctions began to appear in the 1990s and very quickly gained popularity, mainly due to their efficiency and capability to gain significant cost avoidance and cost savings. The first electronic auctions for the public were conducted by FreeMarkets company and were thus pioneers in this field (6). They also found their application in the public sector, where public authorities such as governments use them to select suppliers of public tenders. On this topic, several studies has been already conducted as these tools are very popular in public sector, mainly due to fact that it is significantly harder to undergo corruption in such tenders.

Electronic auctions may be of a dual nature, purchase or sell (some companies conduct selling operations by procurement department, for example byproducts and so on). Sales auctions are an ideal tool to find the best price at which buyers are willing to buy goods (7). Electronic Reverse Auctions (ERA) are reversed in nature and are mainly, but not exclusively, declining in terms of price.

An electronic auction is also defined by the European Directive, which defines it as: " a repetitive process using an electronic device to submit new prices adjusted downwards and/or new values relating to certain characteristics of tenders, which occurs after the initial full evaluation of tenders and which allows the ranking of tenders to be compiled using automatic evaluation methods (3)".

The basic types of electronic auctions (9):

In terms of the number of criteria:

- A) One-critical- we decide according to one, predefined criterion, mostly it is the price
- B) Multicritical- we take into account more than one criterion, and we are able to at weight the criteria. It is a combination of, for example, price and warranty period, etc.

With regard to the visibility of the tenders submitted:

- A) Price-gours see competitive prices or the best and their price in the competition. This type of auction is motivating in nature, as there is a price fight between the bidders. However, this type is not appropriate if the price differences are large or if the lowest bid is significantly lower than other competitors.
- B) Positionally visible: candidates do not see competitive prices, but they see their ranking, either in the selection procedure as a whole or in individual items.
- C) Anonymous or closed- the participants in the auction do not see their ranking or the ranking of competitors, nor do they see competitive prices but only their own. These are mainly Japanese types of auctions, their advantage is the uncertainty of the supplier due to ignorance of the ranking, this motivates suppliers to lower the price.

With a view to the completion of the auction:

- A) Soft-ended auction - in the event of a price change or ranking in the final seconds of an auction, the auction is extended and all bidders receive the same reaction time.
- B) Auctions with a hard end after a set time limit, the auction ends "hard", so if, for example, someone climbs the lowest bid at the last second, others will not be able to react and the auction will close.

In terms of number of auction stages:

- A) The one-stage selection procedure has exactly one stage, which is decisive.
- B) Multi-stage- is a predetermined number of rounds of the selection procedure. Differences in rounds must have clear rules and procedures. However, candidates may not fall out between rounds, there may be different decision-making criteria between rounds and so on. Such auctions depend heavily on the creativity of the promoter.

In this paper, we will recognize mainly 2 auction types defined by company PROEBIZ

(4) :

- ERMMA (English Reverse Multi-item Multicriteria eAuction)- is a multicritical, multi-item auction where a specified group of selected items forming a project unit competes. In addition to price items, other cricket items such as warranty period, invoice maturity, delivery date, etc. may be included in the auction. In doing so, the auction announcer may determine the weights of each criteria in the auction. The prize prize can be total from one vendor or distributed among multiple vendors, according to the best prices or terms of each item.

- NIPPON is a so-called Japanese auction, where the total price decreases over predetermined periods of time. The supplier company reduces the price at periodic intervals and at constant, preset value to the level at which it is willing to perform the work. It is also suitable for investments with a single potential supplier, as suppliers do not see other participants and do not know how many participants participate in the auction. Contractors, so to speak, are "fighting with themselves."

2 Main goals

Main aim of our research in this paper is to quantify effect of electronic auctions during pandemics of COVID-19. It is important for our research to quantify cost avoidance and cost savings that has been reached via electronic reverse auctions.

As a partial goals we determined especially these:

- Summarize theoretical knowledge base of e-procurement ERA
- Structurizing all relevant data of pandemic and pre-pandemic state
- Analyze all relevant outcomes
- Comparison of outcomes with data before pandemics of COVID-19

Both theoretical as well as numerical outcomes of this research is a very realistic overview of effect of using modern e-procurement methods, which can be useful for further research as well as for business use and benchmarking.

3 Methods and data

For our research, we were dedicated to do a research methods as described:

- Composition
- Decomposition
- Analysis
- Statistical methods
- Comparison
- Deduction

For our research, it was very important to gather a long term data from business use of electronic auctions, especially those from ongoing pandemics of COVID-19. These data were gathered from 2 big companies from Slovakia (over 1000 employees). Our main interest into data are specified as:

- Theoretical data from renown scientific papers such as WOS and Scopus
- Quantitative data of e-auctions
- Monetary data from procurement and e-auction softwares
- Qualitative data from employees of procurement department in researched companies

It was very important for our research, not only to gather data from the dates of ongoing pandemics, but also from pre-pandemic dates, in order to do a simple comparison between these two states. In order to achieve a relevant quantity of data needed for our research, we gathered over 5000 specific data blocks, which we further worked with. As not all of data gathered were relevant and useful for us in order to achieve our main goal, we structured this data into relevant groups.

4 Results

In order to analyze current state of use of e-auctions and its further research, we calculated total number of e-auctions done during pandemics in comparison with pre-pandemic state:

Table 28. total quantities of electronic auctions (EA)

Total EA in 2019	138
Total EA in 2020	209

Source: own processing

As of this results, we can see that number of electronic auctions held during pandemic were significantly higher than during pre-pandemic state. This clearly clarifies that companies were much more interested in electronic ways of negotiation. By analyzing this numbers, we spoke with employees responsible for managing e-auctions and they clarified, that they did not intend to do more EA than in pre-pandemic state, just because of comfort and ease of negotiation while working in home office, this method is very useful and user-friendly for them. Procurement manager from one of researched companies also mentioned, that they increased KPI (Key performance indicators) in field of e-procurement and EA in terms of increasing minimum number of EA required per buyer, which could be also another motivation for buyers to use these online methods. We can see increase of use of digital applications almost everywhere from start of pandemics of COVID-19. Businesses are a big part of whole world communication chain, and therefore it is clear that all digital methods that can be used in business procurement, shall be used even more during pandemics of COVID-19.

Another, even more important overview, is an overview of a total cost spent via electronic auctions during researched periods, this will even further clarify, whether increase of total EA held, is done by just increase of budget or not:

Table 29. total cost spent via EA

Total cost spent via EA in 2019	4 mil. EUR
Total cost spent via EA in 2020	3,6 mil. EUR

Source: own processing

From our research, it is clear that overall cost spent via EA is reduced during COVID. We assume that this decrease of total cost spent via EA is mainly caused by total decreases of budgets in between companies. As known, EA's are commonly used for investment procurement and COVID pandemics rapidly cut these budget in most of a production companies worldwide. On the other hand, this results clarifies that total increase of use of EA was not caused by increase of budget, therefore higher cost.

For further comparison, we wanted to see, if increased use of EA also caused better understanding of its work and increased efficiency from point of view of cost avoidance done by EA. We found following:

Table 30. cost avoidance via EA in %

Cost avoidance via EA in 2019 in %	8,58
Cost avoidance via EA in 2020 in %	8,82

Source: own processing

As we can see from upper table, cost avoidance average was slightly increased. This increase is very minor and can not be relevant even in a big scale. We can clarify that procurement EA were not more efficient during its empowered use during pandemics. It is probably also illogical to predict, that just by mean of increased quantity of EA held in businesses, these will be more effective. We also have to assume that pandemics made all of subjects risk-averse, therefore supply chain did not want to provide better prices or to undergo any kind of risk from too low selling price for their customers.

In next step, we analyzed total number of purchase orders created in companies. We have to mention that these numbers are only from investment purchase orders, major repairs and services. We excluded procurement of spare parts, materials and consumables as these are very sensitive to production changes, which could bring us a not relevant point of view on this topic.

Table 31. total number of purchase orders

Total number of Purchase orders in 2019	6343
Total number of Purchase orders in 2020	5827

Source: own processing

As we can see from table above, total number of purchase requisitions was significantly lowered. We assume that it is also caused by decrease of business cost budgets. Positive is that even that companies held significantly less purchases during pandemics, higher percent of these requisitions were negotiated and picked by digital methods – electronic auctions.

At the end, we analyzed if use of electronic auctions helped also in terms of digitization of procurement processes, via data transfer from e-auctions into purchase orders. Findings are represented in table below:

Table 32. purchase orders created via EA tenders

Total number of Purchase orders via EA in 2019	122
Total number of Purchase orders via EA in 2020	174

Source: own processing

As we can see from this table, there is significant increase in purchase orders created via EA tenders, therefore increase of digitization of procurement processes. We can summarize, that during pandemics, digitization was improving across business procurements. Even though that budgets were decreased and there were less total purchase requisitions, more auctions has been done, therefore more purchase orders has been transferred from EA into purchase orders.

5 Discussion

E-procurement is well known term these days and businesses has several options on how to use it and what methods to use. We can claim that main feature of all methods is its usability via internet and digital technologies. These applications are used for variety of cases, from tendering, through logistics and claim management.

During pandemics of COVID-19, world has been digitized even further. Procurement use of electronic auctions has been enhanced. It is simplest and probably most effective way these days for tendering and simple price negotiating. We have to mention that we can use electronic reverse auctions in much more cases than just price negotiation. For example demanding, RFI cases and so on. Pandemics decreased budgets of companies which led to less purchase requisitions in production companies, on the other hand, it enhanced use of digital technologies.

We believe and assume, that use of these digital methods and also all e-procurement, will increase its popularity not only during ongoing pandemics, but also after it. Field of digital innovations is very wide and it will definitely find its new ways into business procurement.

Acknowledgement

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Electronic invoicing information system

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Abstract. Implementation of Electronic invoicing via the Electronic invoicing information system is one of the first steps in the digitization of business. The process of accepting electronic invoicing in the European Union is based on Directive 2014/55/EU which has the goal of decreasing the barriers to cross-border procurement activities, ensuring an interoperable standard/norm for electronic invoicing in public procurement within the boundaries of European Union, and ensuring more straightforward and business-to-business transactions. The transition to this form of invoicing should save a significant part of the costs related to invoicing and significantly speed up and simplify the whole process. Despite the fact that this is a technology that is many years old, state institutions in the Slovak Republic are just beginning to work with this technology. The state's approach also has an impact on the willingness and motivation of private companies to implement it. Different lawful and technical prerequisites of electronic invoices create barriers to access the free market in cross-border public procurement and barriers to trade as they deter economic operators from engaging in cross-border public procurement activities. The aim of the article is to point out the requirements and technical standards, advantages, and disadvantages of the implementation of electronic invoicing information system accent with an emphasis on the current situation in the Slovak Republic. Due to the fulfillment of the main aim, analysis, synthesis, comparison, induction and deduction are used in the article.

Keywords: Electronic invoicing, Electronic invoicing information system, Directive 2014/55/EU

JEL classification: G28, H25, L86

1 Digital technologies

The rise of digital technologies, for example, the Internet of Things, or artificial intelligence used in the area of machine learning, robotization, automation, which

immensely affect today's businesses, are present in every area of our lives. Customer expectations in the digital age are rising, forcing businesses to improve and present new business models that take advantage of digital technological advances. The results of zero action can prompt the loss of Generation Y customers due to insufficient technological progress in a competitive digital market. In order for traditional businesses to remain competitive, they must stop avoiding the process of moving towards digital technologies, on the contrary, they must seize opportunities, which must lead to the beginning of the transition to adopting a model that meets the expectations of the digital economy. The introduction of electronic invoicing is one of the first steps in the digitization of business. An invoice is a legal accounting document in paper or electronic form that must reflect the actual supply of products or services and should be linked to a specific taxable transaction, whether the supply of goods or services.

1.1 Digital transformation

Newly emerged digital communication channels, like the use of the World Wide Web to search for information, online communication, mobile applications, different types of digital media, are challenging to understand for the rather traditional banking industry. That is particularly true for the traditional banking models which don't live up to the assumptions of Generation Y.

New financial market participants, such as start-up digital banks and fintech companies, influence and dictate emerging trends in the banking industry, which radically deploy technologies and draw in clients with creative digital banking services and products.

It is therefore essential that organizations in the financial business but also companies providing accounting, auditing, investment services, etc., swap radically from creation and management of financial, accounting, and similar products and services to the area of provision of modern monetary instruments that are required by clients and adapting offers to their necessities [16].

The need for the digital transformation of business entities is an outcome of advances in computerized technologies, advanced digital competition, and the subsequent way of behaving of "computerized" clients.

Verhoef et al [15] identified three stages of digital transformation:

- a) digitization -the activity of converting analog information to digital information,
- b) digitalization - the process of introducing information or digital technologies for efficient use in business in order to change existing business processes and
- c) digital transformation.

Advancements in technology are the basis for an organization to contend in a digital environment, for example by making digital business models that further increment the upper hand of the company over the competition. Based on this context, we can characterize competitive advantage as the process of creating value and the ability to deliver newly created value to customers, followed by the conversion of received payments into profits.

A new business model is presented through the digital transformation by carrying out a new business rationale in order to make and capture value. In the environment of a digitized economy, business entities communicate with clients through a wide range of online interfaces and web applications, often called digital platforms [5].

In order to achieve digital transformation, every one of its stages needs digital resources, which can result in a transformation of a classic enterprise into a digital enterprise. The impact of digital transformation on the structure of the organization is huge, as changes in the structure of an organization should uphold the introduction and reception of digital change.

However, digital technologies alone don't ensure a positive outcome unless the strategy of digital growth is implemented. The success of the implementation process and the results of the implementation are estimated utilizing metrics, which also need to be adjusted by incorporating digital aspects.

An updated business strategy associated with the transition to the digital environment, building and maintaining a market position, and the constant development of the capacity of human capital are the basic factors related to the success of a financial institution. The accentuation on transforming distribution models, further developing worth designs, and developing the impact of a digitized process will increase development and consumer loyalty and provide a solid ground on which financial organizations can grow and innovate [13].

2 Research on electronic invoicing

Tofan [14] studied the issue of preventing the danger of hacker attacks in electronic invoicing systems, researching the technology of detecting attacks on electronic invoicing systems, which is based on machine learning techniques and allows the completion of two goals of research.

The principal goal was to propose a method based on machine learning with the purpose to detect anomalies in electronic invoices and identify anomalies occurring in electronic invoice systems. The subsequent goal was to perform a profound combination examination of abnormal mining ways of behaving to distinguish likely threats in electronic invoice systems and to design and implement an in-depth analysis method based on the collection of these electronic invoice characteristics based on the "median k" and Skip-gram. Trial results suggest that the technique proposed by the [12] can really recognize pernicious assaults yet in addition possible dangers in electronic invoicing frameworks.

Zhou, Che [19] emphasized the existence of tax problems, such as difficulties with invoice management and accounting. They recommend for the market to support electronic invoicing, which the government could support by providing appropriate subsidies, and to motivate companies to prepare optimal tax plans.

In the study Kotyla [10] identifies the principles of the eIDAS Regulation (electronic identification and trust services). Results also emphasized the need for changes in connection with the regulation requiring changes in the current teaching of accounting.

The above-mentioned changes mainly concern the new standards of electronic documents creation, electronic signature, and electronic distribution of bookkeeping documents. In addition, in Poland and the other EU Member States, corrections must be introduced in the study programs of students specializing in accounting, as similar arrangements apply to electronic accounting records, electronic signatures, and electronic supplies throughout the EU [2]. The results of this research also present the opinion of accountants on the eIDAS Regulation and its implications for their practice.

Chang et al [9] found that electronic invoicing has a bright future in the area of payment security. It can be used not only for item traceability as well as to prevent illegal practices from manufacturers suspected of money laundering. Required utilization of e-invoices can improve the accuracy of this alert system.

Hagsten, Falk [6] examined empirically the extent to which a set of basic business characteristics (size of the company, industry, form, and structure of the invoice, and capacity of production), external factors, type of clients, the possibility of access to the advanced information and communication technologies (ICT infrastructure) are connected to the likelihood of sending electronic invoices and the frequency of their use, based on the results of a representative survey of 1,500 Swedish companies. Analyzed were companies with one or more employees in all industry sectors except agriculture, fishery, forestry, public administration, and defense. The results of the descriptive statistics show that 42% of companies used some kind of electronic invoices in 2016. The results of the research show that both internal and external factors have an impact on the use of electronic invoices.

The likelihood of acceptance of electronic invoices is reasonably higher for companies with clients from the government sector and a higher number of invoices. Another variable significant for the scope of electronic invoices is the level of labor productivity. Companies operating in the construction sector are most likely to accept electronic invoices and manufacturing companies will increase their use. In addition, neither industry membership nor enterprise size class is decisive. Assuming the size class of the enterprise is assessed independently, apparently medium and large enterprises associate the invoices with the type of client, while the scope of activity is connected only to internal factors. On the other side in the case of micro and small businesses, the type of client seems to be the most important aspect.

Horák, Bokšová, Strouhal [7] examined approaches to electronic invoicing in the public procurement process in the European Union. They analyzed the process of receiving electronic invoicing within different EU member states, with the orientation to business-to-government (B2G) contracts. Directive of the European Parliament and of the Council of the EU no. 2014/55 emphasizes the existence and use of several global, national, regional, and corporate standards in the field of electronic invoicing in the EU Member States. None of these standards are prevalent and the majority of these standards are not compatible with another. The acceptance of electronic invoices depends on Directive 2014/55 with a definitive goal to reduce boundaries to cross-border procurement activities, ensuring an interoperable norm/standard for electronic invoicing in public procurement in the EU, and guaranteeing more straightforward B2B transactions.

Without a unified standard for electronic invoicing, the states of the EU can freely decide on the use and improvement of their existing systems based on the different national guidelines and standards while promoting the utilization of systems of electronic invoicing in public procurement. The number of simultaneously existing various norms in the Member States is subsequently expanding and is probably going to increment further in the future [1].

The diversity of non-compatible standards brings disproportionate complexity, legal uncertainty, and extra operational expenses for financial operators involving electronic invoices in the different Member States. Companies wishing to do cross-border public procurement activities are expected to agree with a new standard on electronic invoicing whenever they enter market of another state. Different legal and technical necessities for electronic invoices establishes barriers to free market access in cross-border public procurement and barriers to exchange as they deter companies from engaging in cross-border public procurement activities. They constitute obstacles to fundamental freedoms and therefore straightforwardly impact on the functioning of the internal market [1].

In addition to the transposition of the Directive and its subsequent notification, Member States are required to guarantee that contracting sides or entities get and handle electronic invoices that follow the European standards for electronic invoicing in public procurement.

Subsequently, the directive regulates the requirements of an electronic invoice and the method of adoption and publication of a European standard.

The relevant European standards are technical standards, transferred to the national STN system under the designation:

- STN EN 16931-1 + A1: 2020 Electronic invoicing. Part 1: Semantic model of basic elements of an electronic invoice (36 9640)
- STN EN 16931-1 + A1: 2020 / AC: 2020 Electronic invoicing. Part 1: Semantic model of basic elements of an electronic invoice. AC repair
- STN P CEN / TS 16931-2: 2017 Electronic invoicing. Part 2: List of syntaxes complying with EN 16931-1 (36 9640)

From the point of view of the scope of the directive, this does not apply to the so-called defense contracts if they relate to classified information or are accompanied by other security measures.

Member States had the obligation to implement the Directive by 18 April 2019 at the latest for central government and by 18 April 2020 at the latest for all VO / O. This obligation was not fulfilled by the Slovak Republic.

The main aim of the research [7] was to find out which EU Member States followed this directive and afterward to look at the rules on electronic invoicing that can be valid in all EU Member States. The methodology of research was a comparative analysis of data transfer by electronic invoicing between the provider and the client from the point of view of B2G. The research team sought to address the accompanying research questions: Which EU Member States or European Economic Area (EEA) nations have

rules for B2G electronic invoicing? Is it required to utilize B2G electronic invoicing during the obtainment cycle or is electronic invoicing just a deliberate choice of the organization or state establishment in the chosen country? What platform is utilized for the data transfer of electronic invoices? Is the invoicing platform provided by a state establishment or a private company? This research analyzed data from 28 EU Member States and 3 EEA countries. Data from the Member States on electronic invoicing distributed by the European Commission and all Member States were analyzed.

Even though the main objective of Directive 2014/55/EU is to guarantee the interoperability of electronic invoicing standards, numerous Member States actually have their own, specific way to deal with electronic invoicing. The three primary options to access the electronic invoicing platforms are those provided only by government providers, second are invoicing platforms provided by a private enterprise, and third are invoicing platforms that provide a choice between a government or a private supplier for electronic invoicing processing. More than 10 states that were included in the research actually don't have existing regulations on electronic invoicing. Besides, B2G electronic invoicing is on a voluntary basis in 12 countries according to the information from 28 EU Member States and 3 EEA countries. In a conclusion, these Member States don't comply with the above-mentioned EU directive.

The Slovak Republic, since 1 August 2019, has fulfilled the requirements of Directive 2014/55 / EU by adopting Act no. 215/2019 on guaranteed electronic invoicing and the central economic system and on the amendment of certain laws [12].

If we look at the way the electronic data is transferred only in Norway and Iceland they are provided exclusively by privately owned businesses. In Norway and Iceland authorities have passed the whole agenda of electronic information transmission to private enterprises. In Sweden and the Netherlands is available a possibility, that companies can choose between a private or public platform as a carrier of the electronic invoicing process. The authors of the study are persuaded that electronic invoicing, which is presently utilized in B2G contracts, will turn into the reason for the implementation of electronic invoicing in B2B contracts and guaranteeing compulsory use by law, as is now the case in Italy [7].

Vieira et al. [16] are examining the benefits of introducing an electronic invoice, which represents an increase in tax revenues in Brazil (Goiás). The results indicated that the average tax collection in the State of Goiás was statistically higher in the period after the introduction of the electronic invoice and also confirmed a higher increase in the collection of companies required to issue an electronic invoice compared to those not required during the research period. Thus, the main focus of electronic invoicing is not to increase tax collection, it can be observed that the institutionalization of the standardization program and the sharing of fiscal documents included improving tax administration control processes, increasing the collection of state taxes by reducing tax incapacity.

3 Requirements and Technical Standards for Implementation and Deployment of Electronic Invoicing Information System (IS EFA)

The CEN / TC 434 Electronic Invoicing technical group established by the European Committee for Standardization (CEN) has prepared a European standard (EN) for electronic invoicing in public procurement and a list of syntaxes that comply with the EN, and subsequent technical specifications and technical reports related to electronic invoicing. in public procurement. At the end of 2017, European standards and some technical specifications were transferred to the national STN system by an announcement in the ÚNMS SR Bulletin.

Binding technical standards for the implementation and deployment of IS EFA are:

- STN EN 16931-1 + A1: 2020 Electronic invoicing. Part 1: Semantic model of basic elements of electronic invoicing (36 9640)
- STN EN 16931-1 + A1: 2020 / AC: 2020 Electronic invoicing. Part 1: Semantic model of basic elements of an electronic invoice. Correction AC 25.
- STN P CEN / TS 16931-2: 2017 Electronic invoicing. Part 2: List of syntaxes conforming to EN 16931-1 (36 9640), the following two syntaxes:, the following two syntaxes:
 - UN / CEFACT Cross Industry Invoice XML report as defined in the XML Schem 16B document (SCRDM - CII),
 - Messages for UBL invoices and credits as defined in ISO / IEC 19845: 2015.

The recommended and supplementary technical standards in the implementation of the IS EFA are:

- STN P CEN / TS 16931-3-1 Electronic invoicing. Part 3-1: Methodology for linking syntaxes to the basic elements of an electronic invoice (CEN / TS 16931-3-1: 2017),
- STN P CEN / TS 16931-3-2 Electronic invoicing. Part 3-2: Syntax link for invoice and credit memo ISO / IEC 19845 (UBL 2.1) (CEN / TS 16931-3-2: 2020),
- STN P CEN / TS 16931-3-3 Electronic invoicing. Part 3-3: Syntax link for cross-sector invoice UN / CEFACT XML D16B (CEN / TS 16931-3-3: 2020),
- STN P CEN / TS 16931-3-4 Electronic invoicing. Part 3-4: Syntax link for UN / EDIFACT D16B invoice (CEN / TS 16931-3-4: 2020),
- TNI CEN / TR 16931-4 Electronic invoicing. Part 4: Handbook for interoperability of electronic invoices at the transmission path level (CEN / TR 16931-4: 2017),

- TNI CEN / TR 19931-5 Electronic invoicing. Part 5: Guide for the use of sectoral and national extensions in conjunction with EN 163931-1, method of use in the real environment (CEN / TR 16931-5: 2017),
- TNI CEN / TR 16931-6: 2017 Electronic Invoicing. Part 6: Results of testing EN 16931-1 with regard to its practical use by end users.

In addition to the above recommended and supplementary technical standards:

- in the CEN approval process, the technical specification FprCEN / TS 16931-7: Electronic Invoicing - Part 7: Methodology for the development and use of EN 16931-1 compliant structured Core Invoice Usage Specifications,
- and in the design process the technical specification prCEN / TS 16931-8: Electronic Invoicing - Part 8: Functional specification and guidance for registry services.

3.1 Electronic invoice

An electronic invoice means an invoice that contains data pursuant to Section 74 and is issued and received in any electronic format [18]. The choice of format is not determined by the Member State, but the use of the electronic format depends on the taxable person. These can be invoices as structured messages, such as XML, or other types of electronic format, such as PDF. The law makes the issuance of an electronic invoice conditional on the consent of the recipient of the goods or services. This consent can be expressed in writing, electronically - by email, orally, or by the processing of the invoice by the recipient or its payment. The recipient must be sure that he is technically able to accept the electronic invoice and ensure the authenticity of its origin, the integrity of the content, and its legibility[4].

In other words, e-invoicing or Electronic Invoicing is the electronic transfer of billing information. E-invoicing is an essential part of an efficient financial chain that connects the internal processes of accounting units to payment systems. In the process of e-invoicing, we must respect the procedure (billing), which is a process associated with the invoicing. The billing is followed by payment between business partners (customers and suppliers) [8].

In a simpler sense, e-invoicing can also be defined as a process that consists of sending invoices, making them available, and then saving them. It is a process related to the activities related to the invoicing itself but by the use of electronic means. E-invoicing consists of all steps from purchase to payment and from order to delivery.

3.2 Integration of e-invoicing and advantages and disadvantages of using e-invoicing

Electronic invoicing via Internet banking was first used in practice in 2003. As part of this process, an invoice can be loaded and downloaded in the same way as normal payment transactions in a payment system. The supplier prepares an invoice in its internal information system on the basis of the specification and sends it directly to the

customer or to his bank via the application of internet banking. The bank will use the identification data (IČO, IBAN) to send the invoice either directly to the customer or to another monetary institution. The customer then uses the Internet banking application to download the invoice and into his internal information system. The great advantage of such cooperation between electronic invoicing and electronic banking is that clients use a familiar environment, i.e. the internet bank environment [14]

Electronic invoicing is provided by electronic means and special information channels. A predefined procedure using detailed invoicing is used for electronic invoicing. The first step comes from the supplier. The electronic invoice must be processed in the internal information system of the accounting unit. After recording the e-invoice in the system, the e-invoice is sent to the customer. The e-invoice is considered to be accepted in the moment when the so-called electronic announcement resp. notification is sent. We consider this notification to be a one-time delivery of the invoice by the supplier [11].

For many entities, e-invoicing is a step forward, as many benefits come. One of the most important is automation and integration in payment transactions, from the order itself to payment between customers and suppliers. Another advantage is the increase of transparency in business relations. This increase means that trading parties are able to obtain information faster and more efficiently, for example about the creditworthiness of the counterparty. This type of invoicing also streamlines the control of internal systems, which are aimed at combating unfair practices of employees working in the financial department of the accounting unit. If we look at domestic business relations, here we will include the registration of value-added tax electronically among the beneficial effects of e-invoicing [14].

However, one of the most obvious benefits of using e-invoicing is the faster transfer of money from customers to suppliers reducing the cost of printing, postage, or archiving invoices. Like any system, e-invoicing faces various obstacles. E-invoices can be prepared in various formats and according to many standards, which prevents the smooth transfer of the invoice from a supplier to customer and reduces all savings and costs associated with e-invoicing. Different e-invoice formats slow down interstate communication in the field of e-invoicing. Many potential users have concerns about the security of e-invoicing systems as well as the possibility of distorting the data contained in e-invoices. [5]

Slowly, most accounting invoices are moving from paper invoicing to electronic invoicing, mainly due to the greater accuracy and the speed of creating accounting documents.

4 Conclusion

The aim of the article was to point out the requirements and technical standards, advantages, and disadvantages of the implementation of electronic invoicing information system accent with an emphasis on the current situation in the Slovak Republic. In the Slovak Republic, electronic invoicing is increasingly used as an

opportunity for savings for companies, a reduction in the burden on the environment, but also a way to collect taxes more efficiently.

If we should answer the question of whether the brake in the implementation of electronic invoicing in the Slovak Republic is too demanding or vague legislation, then we can refute it. Technical requirements are also not a significant problem, although the acquisition costs for its implementation are high for many companies. From the experience, it can be seen that this investment will return to companies within a time horizon of up to 1 year.

The state of use of electronic invoicing is then rather below the EU28 average (EU 27 from 31 January 2020.).

The main trend is to move from sending paper invoices to sending invoices that do not allow automated processing via e-mail. In this type of invoices, the Slovak Republic is one of the countries with the highest share of invoices sent in this way. Companies in the Slovak Republic are therefore interested in cost savings, but the low level of implementation is a hindrance, especially for small companies that do not have the bargaining power to convince their suppliers and customers to switch to electronic invoicing.

Based on the processed information in the article presented above, we can state that the objective has been met.

<https://news.cgtn.com/news/2022-03-30/Foreign-minister-of-China-Russia-meet-in-Anhui-18OTL2V0Lny/index.html>

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Financing Innovation with a Focus on Venture Capital

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Abstract. Innovation, research and development are directly linked to the overall global competitiveness of countries and support overall economic growth. Innovation is primarily associated with the improvement of certain areas, products or services. It is based on improving the framework conditions and access to research and innovation funding to ensure that innovative ideas lead to the creation of products and services that deliver growth and jobs in each country. Entrepreneurs decide on the possibilities for obtaining additional finances on the basis of corporate goals, company development and strategic intentions. At present, companies do not have to rely solely on their own sources of financing or bank loans, as the market also offers alternative sources of financing. Companies can benefit from the help of investors who, in addition to providing finance, also offer important experience and advice in the business area. These sources also include venture capital, which is particularly important for small and medium-sized companies with growth potential, which are mostly exposed to high risk and have a low creditworthiness to obtain additional resources. EU funds and programs contribute to solving structural problems and to supporting growth and competitiveness in Slovakia. The aim of this paper is to provide an overview of the various sources of financing innovation in the company with a focus on the use of venture capital in Slovakia and other EU countries. The paper also identifies the main barriers that limit the innovative activity of companies.

Keywords: Financing innovations, Venture capital, V4 countries

JEL classification: G 15, G 24

1 Introduction

We can approach innovation from different perspectives and serve different purposes. We encounter innovations on a daily basis and make our lives much easier. At present, the quality of life is highly dependent on the constant increase of added value in all

areas. Innovation is primarily associated with the improvement of certain areas, products or services. The implementation of marketing innovations supports the sale of products, their main task is to engage the customer through a new design, packaging or promotion. Organizational innovations are related to the overall change of organization and structure in the company. Innovative changes in processes are mainly related to changes in technology, which is also closely related to product innovations. This article provides various opportunities and information in the field of obtaining funding from various funds and programs of the European Union. Main goal is to improve the framework conditions and access to research and innovation funding to ensure that innovative ideas lead to the creation of products and services that deliver growth and jobs in each country.

1.1 Financing Innovations

Innovation is key to improving living standards and can affect individuals, institutions, entire economic sectors and countries in different ways. The correct measurement of innovation and the use of research innovation data can help policy makers better understand economic and social change, assess the contribution of innovation to social and economic objectives, and monitor and evaluate the effectiveness and effectiveness of their policies. (Oslo manual, 2018)

The most widely used and widely used classification of innovation is the OECD-Oslo Manual Classification (2005). The Oslo Manual is a document defining basic concepts in the field of innovation and innovation processes. The OECD Oslo Manual defines four basic types of innovation:

Product Innovation – An upgraded product (an innovated product (good or service) is an indication of a product that is new or significantly improved. This innovation includes significant improvements to its characteristics, technical specifications, components, materials, in-product software, user accessibility, or other functional characteristics.

Process innovation – Process innovation - a new or significantly improved way of production or system of suppliers and distributors. This innovation also includes significant changes in technology, equipment or software.

Marketing innovations – represents the introduction of a new or significantly improved marketing method, which includes significant changes in connection with the design or packaging of the product, product placement, product promotion or product pricing.

Organizational innovation – are characterized by the introduction of new organizational methods in the structure of the company, workplace organization or external relations.

The evaluation of innovation can be carried out at two levels - microeconomic (corporate) and macroeconomic (regional, national). At the microeconomic, i.e. corporate level, the level of innovation can be measured by research and development, the efficiency of production processes, customer satisfaction, the transfer of innovation and technology, the motivation of employees, etc. This level includes, for example, the

revenue from the sale of new products, research and development costs, the life cycle of a new product, the number of patents or the introduction of new production and information technologies.

At the macroeconomic level, the assessment and measurement deals with the competitive advantages of regions or states. In this case, innovations can be evaluated using different frameworks and pre-prescribed indicators dealing with technologies, human resources, transfer, processes, or marketing. Another way is to monitor research and development spending as a percentage of GDP (Sabadka, 2009).

1.2 Innovation Funding Opportunities

We allocate sources of funding for innovation into private and public sources of funding. Private sources of financing innovation include internal and external resources of the enterprise, banking resources, venture capital and business angel resources. Public sources of funding for innovation include state and regional financial support and European Union financial resources. We include framework upgrade, structural funds and other financial resources among the financial resources from the European Union (Burger, 2016).

EU funds and programs contribute to solving structural problems and to supporting growth and competitiveness in Slovakia. Slovakia is one of the largest recipients of solidarity from the EU. From the multiannual financial framework, Slovakia receives support of more than 15 billion EUR to address development challenges, equivalent to around 2.5% of GDP per year. This budget is used to invest in a variety of areas, from job creation to growth and promotion of sustainable transport, environmental protection to investment in research and innovation. It is R&D expenditure that is intended to help the transition from a predominantly production-based economy to an economy based on domestic innovation and technology (European Commission, 2019).

1.3 Financing Innovation from Repayable Sources

The most frequently used sources for financing innovations from repayable sources are bank loans, venture capital and other sources of financing through funds at the national and international level for entrepreneurs.

Supporting innovation by SMEs is necessary for EU competitiveness and employment rate. The European Commission to set aside funding in 2014-2022 to support investment in innovative start-ups through venture capital funds. Venture capital is a catalyst for innovation, job creation and economic growth. It can also provide SMEs with capital to improve their access to finance, help get their businesses off the ground. The development of a European venture capital market requires a comprehensive investment strategy to support less developed venture capital markets and reduce dependence on the public sector. The Commission provides support based on project merit and not driven by geographical location of venture capital funds or investment sectors. On the other hand, this approach is demand-based, favouring the most developed venture capital markets. This leads to a concentration of investment in the EU's largest economies, while underdeveloped markets and sectors may receive less

financial support. The EU venture capital market is still highly dependent on the public sector and the low rate of return is one of the reasons for the low interest of private investors (European Court of Auditors, 2019).

Venture Capital	Bank loans	Other financing options
- Venture capital funds operating in Slovakia	- Investment loans - EU funding programmes and open calls - EIB loans	- Innovation fund

Fig. 18. Financing innovations from repayable sources.

Source: Based on data from Slovak Business Agency, 2021

Venture capital investments create and expand business activities, which form a new segment of the business sector and accelerate the production of new knowledge, competitiveness and ensure further economic growth. Venture capital investments can be broken down according to several characteristics. In the broadest sense, if we start from the ideal situation in the development of the company, we distinguish the following types of financing (Chovancová et al., 2006):

- pre-seed funding,
- start-up financing,
- early development financing,
- development financing,
- rescue financing,
- replacement financing,
- managerial redemptions,
- acquisition financing,
- mezzanine.

1.4 Financing Innovation from Non-repayable Sources

Entrepreneurs participate in various operational programs, regional programs and community programs, which offer a wide range of financial assistance, when using non-repayable sources of financing.

Operational programmes	Cross-border cooperation	National Programmes	Community Programmes
<ul style="list-style-type: none"> - Operational Programme Research and Development - European Regional Development Fund 	<ul style="list-style-type: none"> - Interreg V-A SK-CR - Interreg V-A SK-AT - Interreg V-A PL-SK - Interreg V-A SK-HU 	<ul style="list-style-type: none"> - Slovak Research and Development Agency 	<ul style="list-style-type: none"> - Research and Development - Implementation - Marketing

Fig. 2. Financing innovations from non-repayable sources. *Source: own processing based on data from Slovak Business Agency, 2021*

2 Data and Method

To compare innovation activity, we focused on the Czech Republic, Hungary, Poland and the Slovak Republic. At the same time, all these countries are comparable to the average innovation activity of companies in the EU. Country data were obtained from The Community Innovation Survey, which provides information on innovative companies and different types of innovation.

The Community Innovation Survey is based on innovation statistics, which are part of the EU science and technology statistics. The surveys are carried out every two years by EU Member States and a number of European Statistical System member countries. The following figure provides the latest overview of enterprises that carried out innovation activity in the years 2008 to 2018.

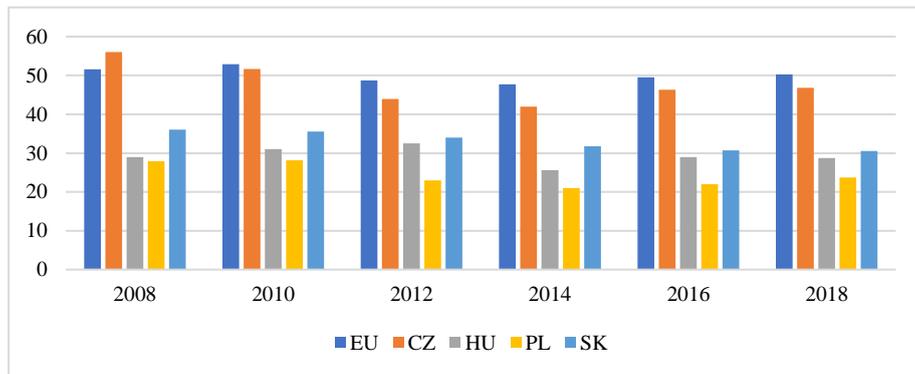


Fig. 3. Enterprises with innovation activities during 2008-2018. *Source: own processing Based on The Community Innovation Survey, 2021*

We can see in the figure that the Czech Republic has the best position among the monitored countries. The number of innovative companies has been at the level of 40-

50% since 2008, which was significantly higher than in the other countries surveyed. The Czech Republic is closest to the European average of innovative enterprises in terms of the number of innovative enterprises. In second place in the number of innovative enterprises was the Slovak Republic, whose number of innovative companies was at the level of 30-40%. However, the number of enterprises with innovation activity decreased steadily during the period under review. The third place was occupied by Hungary and the last place by Poland with the number of innovative companies at the level of 20-30%, which represents only about half of the innovative companies in the EU.

According to the 2018 Community Innovation Survey for Slovak republic, 30,5 % of enterprises in industry and services had innovation activity. However, even in these companies, they encountered problems that limited them in their innovation activities. As the main factor limiting innovation activities, 27.2% of innovative companies consider difficulties in obtaining state subsidies or grants. Excessive costs for innovation are a barrier for 26.3% of innovative companies. The third biggest barrier to introducing innovations was the lack of internal financing, which was reported by 25.8% of companies. The following figure provides an overview of individual hampering factors limiting innovation activities in innovative enterprises.

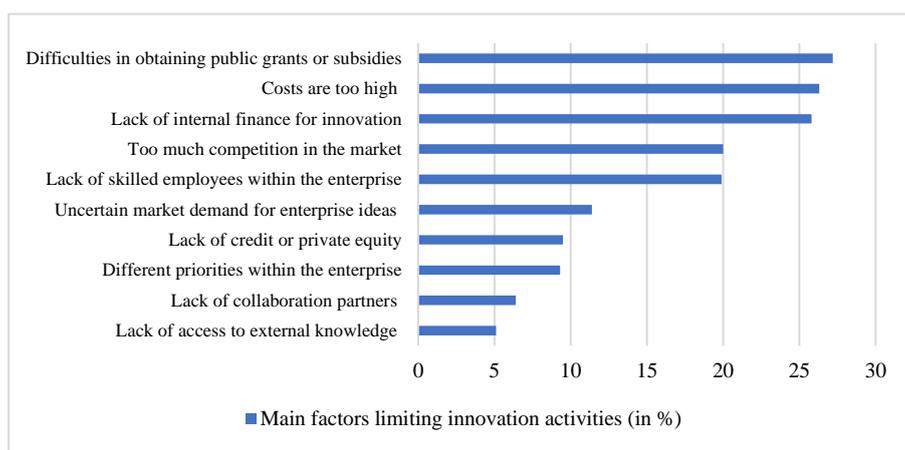


Fig. 4. Main factors limiting innovation activities. *Source: own processing Based on The Community Innovation Survey, 2021*

Based on the observed data for individual countries, a prediction model was created, which shows the expected possible development of innovation activity of enterprises. The prediction model was created using IBM SPSS software, which uses a forecasting feature while providing advanced features that allow to make reliable forecasts using time series data. Using this software we are capable to predict the possible development of the number of innovative companies until 2025, based on observed data.

As we can see from the figure, individual countries have a relatively stable number of innovative companies, most of the surveyed countries, together with the European average, recorded a slight decrease in innovation activity in the period from 2012 to 2017. Nevertheless, they managed to reverse this trend and support the innovative activity of companies in the years 2018 – 2019. The development forecast indicates that individual countries will continue to have a relatively stable development trend and will be at the level of 25 – 50%. The only country with a negative forecast is the Slovak Republic, where a negative trend could occur and the number of companies with innovation activity will decrease if companies do not receive sufficient financial support for innovation. The forecast for the Slovak Republic shows that in the future the number of innovative companies could theoretically be reduced to 25%, from the current 30.5%, which is not a good sign for the economic development of the country.

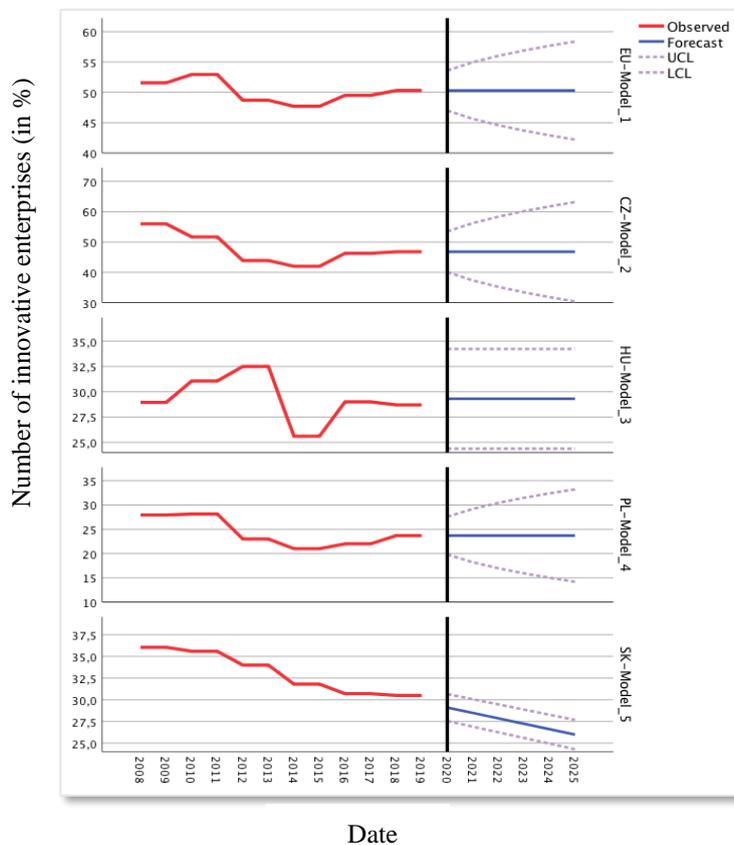


Fig. 5. Prognosis of innovation activities in enterprises. *Source: own processing*

3 Venture Capital in V4 Countries

Invest Europe, an association representing European private equity, venture capital and the infrastructure sector, as well as its investors, today published private equity statistics for Central and Eastern Europe in 2020. Private equity companies invested in a record 566 companies in Central and Eastern Europe in 2020, mainly due to dynamic small and medium-sized enterprises and startups, which supported the recovery from the impact of COVID-19 and long-term economic and social development across Europe. The report shows that the number of companies receiving private equity investments increased by 15% to the previous year's record and exceeded the five-year average by 46% (Slovca, 2021).

Table 33. Type of investments by country, 2019-2020 (in € thousands). *Source: Own processing based on data from Invest Europe, 2020*

STAGE FOCUS	CZECH REP.		HUNGARY		POLAND		SLOVAKIA	
	2019	2020	2019	2020	2019	2020	2019	2020
<i>Seed</i>	1 404	792	33 082	50 243	5 932	16 670	0	5 570
<i>Start-up</i>	9 768	9 015	71 163	49 880	51 138	45 091	16 247	13 645
<i>Later stage venture</i>	13 130	4 400	34 095	25 410	43 855	50 157	5 725	1 700
Total venture	24 301	14 207	138 340	125 532	100 925	111 918	21 972	20 915
<i>Growth</i>	125 502	25 000	27 581	40 883	92 777	123 850	9 756	1 500
<i>Rescue/Turnaround</i>	0	0	1	7 314	0	0	2 000	0
<i>Replacement capital</i>	0	0	0	0	11 845	0	0	0
<i>Buyout</i>	87 679	240 653	54	52 553	382 990	195 171	6 000	0
Total	237 482	279 860	165 976	226 283	588 536	430 939	39 728	22 415

Based on the table, we can see that among the V4 countries in 2019, the Slovak Republic was the country that used the least risk capital. In the following year 2020, the Slovak Republic ranked 3rd among the monitored countries, when the Czech Republic used risk capital the least. The risk capital in both used mainly as Seed Capital, Start-up capital or as Later Stage Capital.

In 2020, the Slovak Republic was the only country that did not use the management buyout, which is a transaction where a company's management team purchases the assets and operations of the business they manage. A management buyout is appealing to professional managers because of the greater potential rewards and control from being owners of the business rather than employees.

The overall venture capital utilization ratio decreased among the years. The most significant decrease in the use of venture capital was observed in the Czech Republic,

while Poland was a country where the use of venture capital increased. The following figure shows the degree of risk capital involvement according to the stage at which the company is located.

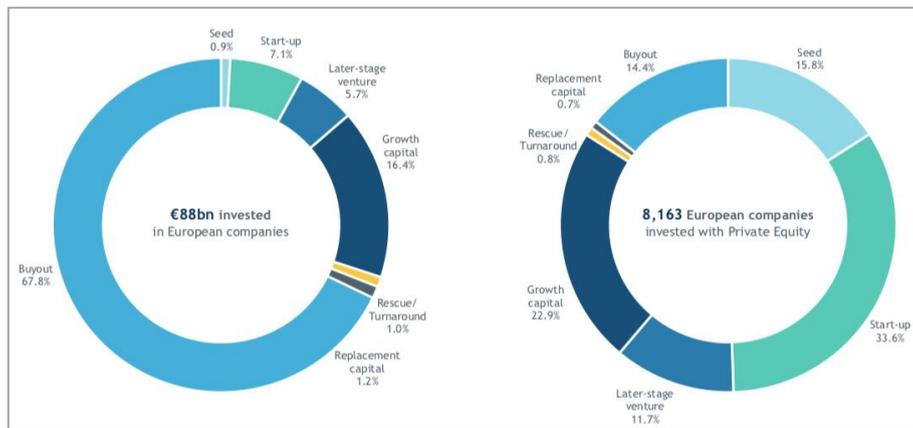


Fig. 3. Investments by stage, 2020. Source: Invest Europe, 2020.

In 2020, the most frequently used financing was management buyout of a company, when investors used a significant amount of borrowed capital to cover costs. Usually by buying a majority or controlling shares.

The second most commonly used form of investment was investment in the growth capital, which was often a minority investment. Nevertheless, this type of investment enters relatively advanced companies looking for capital to expand and improve operations or enter new markets in order to accelerate business growth. The third most common method of financing was to finance start-up companies after full product or service development. This capital investment is used to cover capital expenditures and initial working capital.

4 Conclusion

Central and Eastern Europe has recently been seen as a fast-growing hub in Europe, attracting local and global investors, resulting in large-scale new accelerators, a VC fund and the availability of early-stage funding in the region. However, the activity of private equity funds in Slovakia is relatively small compared to international companies. The Slovak Republic offers a relatively limited market, which also generates fewer investment opportunities with growth potential.

In comparison with the innovation activity of companies between countries, it was clear that the innovation potential of the Slovak Republic has had a negative direction in recent years. The Czech Republic has the highest innovation activity of enterprises,

which is also at the level of the European average in the number of innovative enterprises.

Foreign investors are also more interested in larger markets, such as Poland, which has experienced high investment growth in recent years. Venture funds are usually invested by wealthy individuals, banks, but also the public sector, as evidenced by a number of venture capital funds in Slovakia with the participation of public funds.

One of the reasons why this type of capital is so rarely used in Slovakia is the relatively low awareness of Slovak entrepreneurs about venture capital and the readiness of companies for this type of financing. On the one hand, there are entrepreneurs who complain that they have lack of capital and their companies are undercapitalized. On the other hand, there are investors who talk about the lack of investment opportunities as the Slovak Republic represents a relatively small investment market.

The most frequent ventures or private equity investors are mainly looking for companies with high growth potential, which cannot always be found in the Slovak business environment. All these factors also contribute to the fact that financing innovations through venture capital and private equity is used much less in Slovakia than in the surrounding countries.

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Age Management application and its anticipated advantages in the Slovak Republic

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Abstract. Age management is the reaction of the management theory and practice on the trend of the population aging in developed economies, where it already represents established, but not generally applied management area. The introductory part of this article defines basic definitions of the Age management and the following part summarizes justification of the need for the Age management application in the Slovak Republic, using the argumentation based mainly on synthesis of actual and expected demographic evolution and changing population participation of different age groups of population on the labor market. Potential advantages of the Age management application in general terms and also in the Slovak Republic are summarized in the third part of the article. Summarization of presented research outcomes are outlined in its final part.

Keywords: Age Management, Ageing workforce, Demographic trends, Aging population

JEL classification: J140

1. Introduction

One of the most important trends which will, in the next decade, influence the society, economics and individual companies are accelerating demographical changes, including the aging of the population. It is the global changes connected to the increasing age of the population (the potential working force), introduction of generations X and Y to the labor market, but also the position of customers. This creates pressure onto society, so that age management becomes an important part of politics and company processes. It should also create expectations for its adaptation to new challenges.

From the name is apparent that age management concerns the management of human resources and takes into account the age of employees. It also includes creating conditions which look over age on the political and organizational level, but also management of physical and social areas¹. The European agency for Safety and Health at Work defines age management as a discipline referring to multiple dimensions, by which are human resources managed in organisations, with the explicit focus on the aging workforce. More generally, age management means managing the aging workforce through multiple public policies or collective debate². The basic principles of age management according to this source include:

- focus on prevention rather than reactive problem solving,
- focus on the whole duration of work activity and all age groups (not only the older employees),
- a holistic approach including all dimensions contributing to effective age management.

Walker, A. (1999) defines age management as measurements eliminating age barriers and improvements of age diversity. Thus, age management is focused on keeping up the employability and work ability of people in all of their life cycle. The main tools of age management include recruitment and firing of employees, their education and training, personal improvement and work progress, flexible working conditions, ergonomics and appropriate definition of the workload. One could argue that age management shouldn't focus solely on older employees, because the changes implemented on specific age groups can be contra productive: the younger employees could view the preferential treatment of older employees as unfair, and the older employees could feel stigmatized. Therefore, age management should take into account the abilities and needs of all age groups and adjust them to the company's needs.

According to the Ministry of labor, social affairs and family of SR, age management looks over the different dimensions of human resource management, on the level of the organization with a particular focus on appropriate inclusion of all age groups. Also, more generally, on the whole management of the aging population through public policy or collective debate³. According to this source, age management has a holistic, inter-generational and lifelong orientation, while the strategies of age management should be aimed to all age groups of employees.

Closely tied to age management is the concept of work ability. It is one of the examples of supporting taking charge of own aging, which is one of the central concepts of age management. This concept of work ability was defined at the end of the 90s of the 20th century by the Finnish institute FIOH. It highlights that the individual work ability is the result of the relationship between the resources of the individual (health

¹ Cimbáľníková et al. (2012)

² European Agency for Safety and Health at Work (2021)

³ MPSVaR (2017)

and functional capacity, education and competency, values, views and motivation) and their produced work. From past research stems, that work ability changes in the life cycle of the individual, all while with the increasing age has a tendency to decrease. Wallin (2015) defines work ability as a dynamic relationship between resources of the individual and the resources available at the working space.

Because of demographical changes, age management is currently an established tool (in a way also an aim) of management in advanced economics. The application of modern tools of age management has the potential not only to a sustainable economic growth, but also general social cohesion (especially in terms of inter-generational solidarity).

2. Reasons of the necessity of age management application in SR conditions

Despite that the concept of age management is present in foreign literature and business practice for a few decades, in the conditions of SR is the situation drastically different, especially on the practical level. One of the logical reasons for why there wasn't more focus on the concept of age management is most likely the already existing age structure of workforce in the SR. Nowadays, the labor market of SR is dominated by members of the younger and middle-aged generation aged 30 to 44,99. This can be placed in contrast with the EU average, where the biggest group (in groups with age intervals of 5 years) are people aged 50 to 54,99.

For a more complex discussion of demographical age factors that influence the labor market is important to consider also the expected trends and not only the current ones. From the data in Figure 1 it is clear that the population of SR currently belongs to the youngest ones, while also being the fastest aging in terms of the EU. In other words, a fast-aging population will in the near future drastically change the environment of the Slovak labor market. The median for the population of the SR had in the year 2019 a value of 40.6 years, which is the seventh lowest value in the EU. The median for the whole of EU in the year 2019 reached the value of 43.7 years. Comparing it to the year 2009, the median of age has increased by 4 years, which belongs to the highest of values in the EU. Other than the SR, the median has increased between the years 2009 and 2019 by 4 and more years in only five other countries: Ireland (4.1 years), Greece, Latvia (both by 4.2 years), Portugal (4.4 years) and Spain (4.6 years). In Italy, the country with the oldest population of the EU, the median of citizens has increased in the last 10 years by 3.7 years to 46.7 years of age.

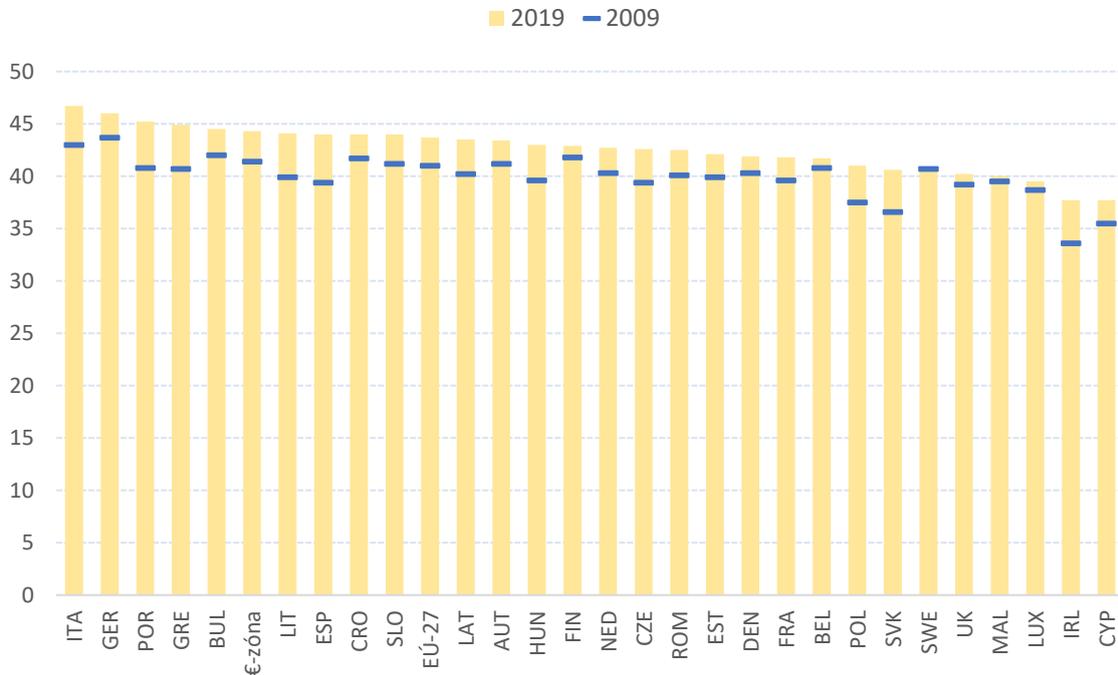


Figure 1: Median of the age of citizens in EU countries, comparison of years 2009 and 2019

From the viewpoint of age management and the prognosis of work offers it is necessary to take into consideration the extent of work participation of each of the age groups, not only the number of members in each. By the synthesis of current and expected demographical evolution and current “formulas” of the changing measures of participation during our life cycle we can conclude that the structure of the whole work offer in the Slovak economics will drastically change in the upcoming decade. This is illustrated in Figure 2. In the year 2030, compared to 2019, the general work offer (in this case defined by the number of people) in the age group ranging from 20 to 44.99 will decrease by 307 thousand members. This is in contrast with the age group from 45 to 59.99, which will increase by 148 thousand members⁴.

Comparing it with the present, the ratio between workers of the younger and older generation will palpably change. The demographical trend of the aging population in the EU has appeared, comparing to the SR, a few decades earlier. Knowing this, the authors Naegele and Walker concluded in the year 2006 that EU employers shouldn't count on an appropriate offer of young employees⁵. Current demographical trends

⁴ For a more detailed estimate look Stuller (2021)– Demographic development in the Slovak Republic in relation to the Age Management

⁵ Naegele a Walker (2006)

going on in the SR create an acute need for the application of age management, especially on the levels of the individual, organizational units (companies) and the level of state and public policies. All mentioned levels will have to, in the near future, contribute with appropriate measures of age management for creating appropriate offer of workforce in the entire Slovak economy. This is in the interest of sustaining its functionality and ultimately also its ability of managing competition.

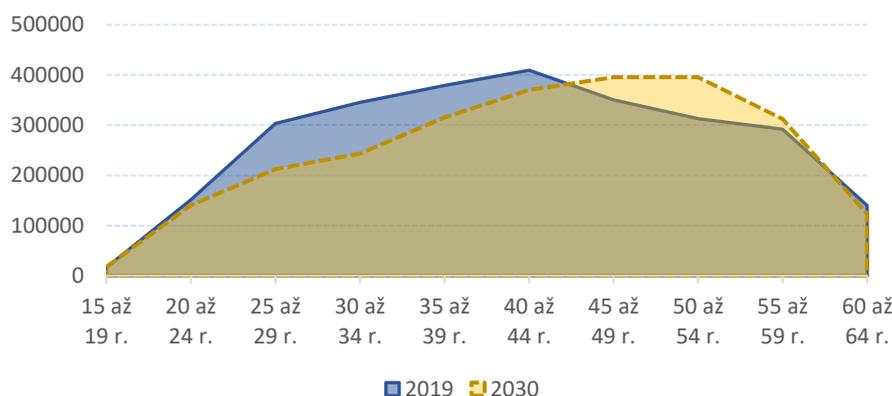


Figure 2: Comparison of current and expected structure of the general work offers in SR from the viewpoint of the age of employees

Note.: the work offers for individual age intervals is calculated as a multiplication product of the number of citizens and the rate of participation in terms of the given age interval

Source: Calculations by Eurostat author

3. Possible benefits of age management application

The application of age management on all of its levels has the potential to bring the following benefits:

- a) **Individual level**, on which age management is concerned by the individual and their work process. It focuses on their viewpoints and interests, with the aim that the individual accepts the reality of a long work journey sooner than aging takes effect. In other words, the aim is the sustainability of a high work ability and motivation of the individual also in older age, especially an effective use of their abilities. The application of age management on the individual level is an opportunity for the participation of the individual in the labour market for as long as possible, all while the key tool of adaptation for everchanging needs of the labour market and also the dispositions of the

individual with increasing age are active precautions in the form of training and education of employees, requalification of the unemployed and so on.

The aim of age management application is sustaining the highest work ability of the individual as possible. This brings the benefits to not only the individual themselves, but also the company, namely by increasing the general work offers and range of employee qualifications. Widely used tool of work ability measurement is the work ability index (WAI)⁶. The items of WAI are shown in Table 1.

Table 1: Items of WAI

ITEM NUMBER	NAME	POINT RANGE
1.	Current work ability compared to the life maximum	0-10
2.	Work ability compared to the expectations of the work position	2-10
3.	Number of illnesses diagnosed by a doctor	1-7
4.	Expected losses in work because of illnesses	1-6
5.	Work inability for the last 12 months	1-5
6.	Own prognosis of work ability for the next two years	1-7
7.	Mental capacity	1-4

Source: Ilmarinen (2007)

WAI brings a whole range of practical implications. We can intuitively conclude that health issues, unhealthy lifestyle, demotivation and stagnation lead to a lower work ability and often premature pension leave. This connection is shown in Figure 3.

⁶ Tuomi et al (1998)

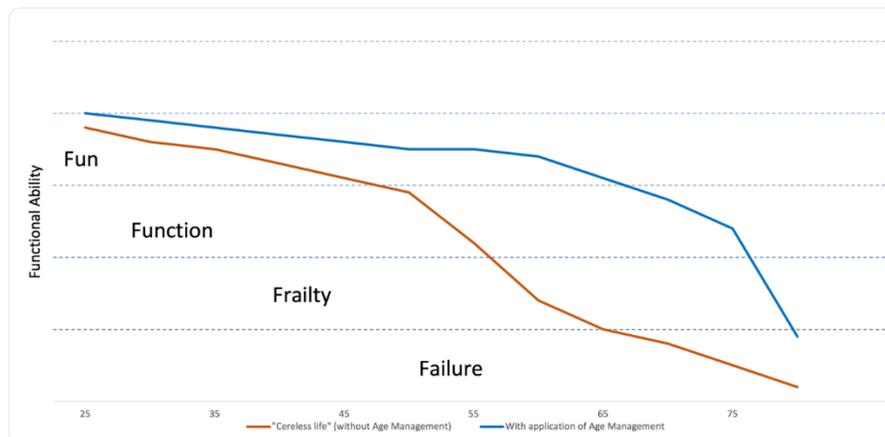


Figure 3: Model example of the connection between the individual and the range of age management application

- b) **Organisational level** focuses on employers as organisational units. The aim of age management on this level is to sustain and develop the human capital of the company as a whole, adjust the competencies and performance of the employees' long term to the needs of the company and work growth. Empirical research has shown that the application of age management on this level could bring a number of benefits:
- Lower fluctuation of employees and stemming from these also lower costs for recruitment and training of employees, leading to higher work productivity.
 - Slower pace of work inability of employees.
 - Higher motivation of employees- if the employees themselves feel more respected and cared for, they usually feel a stronger bond to quality work performance of their tasks.
 - Higher attractivity of the employer and higher degree of employee satisfaction.
 - Effective transfer of know-how between employees of different age generations (for example the transfer of expert soft skill know-how from older to younger employees or transfer of technological know-how from younger to older employees).
 - Age-diversified work team brings many potential benefits (new ideas and views on the problem, sharing of knowledge and experience, more effective problem solving).
 - Building company reputation as an attractive employer, easier recruitment of new employees and better crisis management⁷
 - Maximising the use of existing and dispensable human resources of the company⁸

⁷ Urbancová (2019)

⁸ Naegele a Walker (2006)

- Achieving the competitive advantages of the company regardless of its magnitude and the area in which it stands⁹.

Individual companies and organisations can apply the tools of age management on different scales, while we cannot entirely conclude that there is a consensus of a universal measurement tool for estimating the range of age management application. One of the possible approaches is shown in Figure 4 and it stems from two dimensions of this age management problematics on the organisational level:

1. Stance of the organisation to the phenomenon of aging in general and aging of their employees.
2. Readiness of the organisation to face challenges tied to the aging workforce and individual employees.

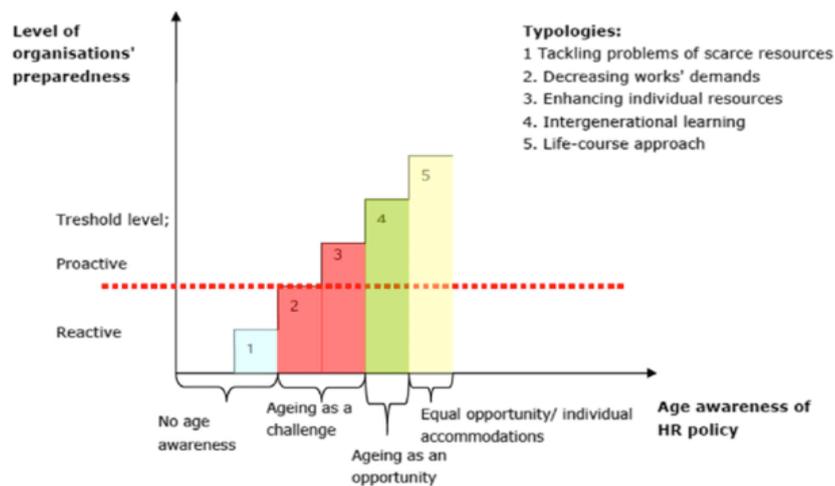


Figure 4: Typology of age management use on the organizational level

c) **Level of state and public policies**, where the aim is to maximise the contribution of all working age generations to the economic and social life. The individual interest of this level lays in the solving of the aging population phenomenon with all of its economic and social risks. Application of age management on this level could bring the company a number of benefits:

- Enough work opportunities for all age categories.
- Growth degree of citizen participation in the labour market, growth of work activity and the general work offer in economics.

⁹ Urbancová et al (2020)

- Increase in the work offer quality by sustaining the work ability of more citizen groups even in higher ages.
- Increase in the sustainability of finances by increasing tax revenue and levies (lower degree of premature pension leaves, lower degree of work inability, lower number of aid recipients that are unemployed).
- Sustainable economic growth and the general social cohesion (especially in terms of international relations).
- Work force with a balanced inclusion of different age groups has the biggest ability to react quickly to everchanging conditions connected to globalisation¹⁰

One of the possible ways to measure the degree of age management application success on the state level is the degree of participation or the degree of employment of different age groups in the labour market¹¹. Connected to age management it's only appropriate to focus on both poles of the age range of the population of appropriate age (youngest and oldest members of the workforce).

Comparing the degree of participation of different age groups in given EU countries is shown in Figure 5. From this comparison we can see clear differences, which can, however, be largely influenced by the different culture traditions and lifestyle choices of each country. But they undoubtedly show the degree of age management application on all of its levels. This is because the data form the whole country is in its way and aggregation (and a showing) of the individual and organisational rules and behavioural formulas. For example, in Croatia, we can see a slightly above average degree of participation in younger generations, while the degree of participation of ages 45 and above is drastically lower compared to the international average. We can see clearly the benefits age management application would bring in Croatia. On the other hand, in Sweden, the degree of participation reaches values above average in all age categories, which demonstrates successful age management application.

¹⁰ Naegele a Walker (2006)

¹¹ Connected to the aging population, the EU has established the aim of degree of older people employability at the beginning of the millennium.

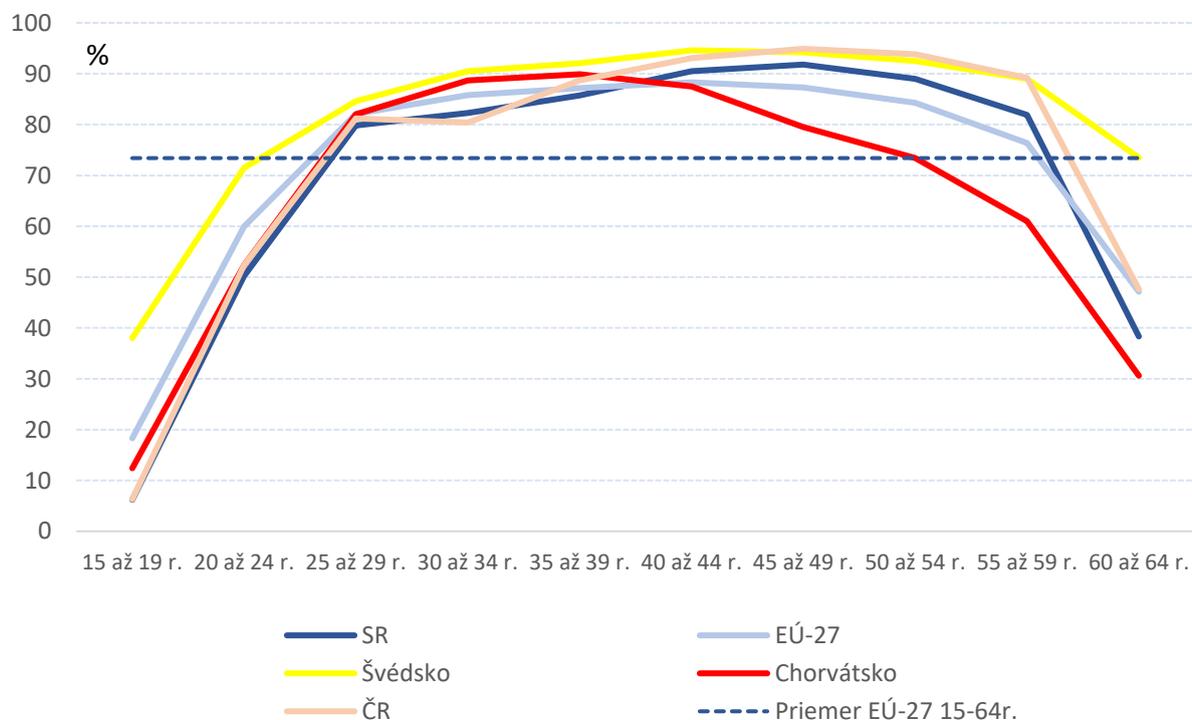


Figure 5: The degree of citizen participation in the labor market according to individual age groups in chosen countries in the EU (year 2019)

4. Conclusion

Because of the current demographical changes, age management is an established tool of management in developed economics. The application of modern tools of age management seems as a necessary predicament of sustainable economic growth, sustainable economy of pension systems and general public finances, as well as social cohesion (especially in terms of international solidarity)

Synthesis of current and expected demographical changes and current formulas of changing degree of participation throughout our lives can illustrate, that the structure of the general work offers in the Slovak Republic will clearly change in the next decade. Current demographical trends in SR create a sudden need of age management application, on the levels individual, organizational and the level of state and public policies. All mentioned levels will have to sooner or later contribute to

creating measures of age management to ensure appropriate offer of workforce and work productivity growth in Slovak economy.

Age management application brings many potential benefits on the level of individuals, organisations (companies) and the whole society. The aim of age management application on the individual level is ensuring the highest work ability of the individual to the highest possible age. In return, this will bring benefit not only to the individual, but also to the whole society by increasing the general work offers and the degree of qualified employees. One of the biggest benefits mentioned on the organizational level is decreasing the degree of employee fluctuation, growth of work productivity and finally reaching the competition benefit of the company, regardless of its magnitude and area of influence. The potential benefits of age management move from the individual and organizational levels also to the level of state, where the developed application of age management shows through an increased citizen participation in the labor market, higher degree of older citizens employability, stabilization of work offers and ultimately through beneficial effects on public finance.

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Specifics of Consolidation from the Point of View of the Statutory Auditor in the Event of Loss of Control

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Abstract. The loss of control of a parent company over the subsidiary is a very specific area of consolidation, which, however, must also be addressed by the statutory auditor. This is called deconsolidation. The aim of this paper is to analyze the process of deconsolidation and reflect it on two practical examples. We will first analyze the specifics of deconsolidation from the point of view of the statutory auditor and then reflect them on practical examples, dealing with two cases - the sale of a subsidiary, which at the time of sale has higher equity than at the time of acquisition and at the time of sale lower equity than at the time of acquisition of the share. We will show how to proceed in these cases, as we will be working with the data on the subsidiary as of the date when the parent company will no longer have control over the subsidiary. Based on the solution of examples, which will be reflected numerically and in tables that will show the individual data in the individual and consolidated financial statements, we will see how deconsolidation will affect the consolidated financial statements in individual cases.

Keywords: loss of control, consolidated financial statements, deconsolidation

JEL classification: *M 41, M 42*

1 Introduction

The tasks of the statutory auditor also include the verification of deconsolidation. These are consolidation adjustments in such a case, if the parent company loses control over the subsidiary, which may happen because of the liquidation of the subsidiary or also, for example, the sale of the share, or part of it, it is the so-called deconsolidation. [2] In practice, the statutory auditor often encounters the incompleteness or omission of deconsolidation. [11] Therefore, it is very important to verify this fact. We can speak of a properly executed deconsolidation procedure if the company disposes of shares in

subsidiaries, which consist in repeating the last consolidation of capital and the subsequent disposal of the assets and liabilities of the subsidiary. [12] However, the entire consolidation process must be in accordance with International Financial Reporting Standard IFRS 10 - Consolidated Financial Statements (hereinafter "IFRS 10"). [8]

In this paper, we focus on the sale of the entire share in the subsidiary, from which the parent company may incur a profit or loss. It depends on whether the subsidiary has equity higher at the time of the sale than at the time of the acquisition of the share by the parent company - then we are talking about the sale of a profitable subsidiary. Otherwise, if the subsidiary has less equity at the time of the sale than at the time of the acquisition of the shareholding by the parent, it is the sale of the loss-making subsidiary. We will reflect both cases on practical examples. [7]

2 Methodology

The aim of this paper is to analyze the deconsolidation process. On two practical examples we will show how to perform deconsolidation correctly in practice. There is a very important fiction of the legal unit. [1] The point is that we will be working with the data on the subsidiary, even if by that date the parent company no longer has control over the subsidiary. It is necessary to maintain continuity and take into account the data on the subsidiary for the part of the period when the parent company still had control over the subsidiary. [4] It is also necessary to take into account, for example, the retained earnings of the subsidiary's previous years. If we do not carry out deconsolidation and do not take into account the data on the subsidiary, the results would be skewed. The consolidated profit or loss would not be adjusted by the profit or loss of the subsidiary, which would also lead to the recognition of an incorrect profit or loss. [9]

3 Loss of control of a parent over a subsidiary

International Financial Reporting Standard IFRS 10 deals with consolidation only very marginally. [8] Under IFRS 10, in the event of the loss of control of a subsidiary, the parent ceases to recognize the assets, including goodwill and liabilities of the subsidiary from the consolidated statement of financial position. [3] The parent recognizes all investments retained in the former subsidiary at fair value at the time of the loss of control, which it then recognizes with the subsidiary's liabilities, if any. The parent subsequently recognizes a gain or loss that relates to the loss of control of the subsidiary. The parent recognizes, if any, the consideration resulting from the loss of control measured at fair value. Furthermore, all items that are recognized in other comprehensive income related to a subsidiary are recognized in profit or loss, or in profit or loss from prior periods. [9] In the following sections, we will focus on simplified practical examples in the field of deconsolidation, in which we will abstract from goodwill, profit from a bargain purchase and non-controlling interests.

3.1 Loss of control of a profitable subsidiary

About the loss of control, the so-called a profitable subsidiary exists when the subsidiary has a higher equity at the time of the sale than at the time when the parent acquired the shares in the subsidiary. The equity of the subsidiary has finally increased, so it is a profit. [12]

We will then explain the consolidation in the event of a loss of control of a profitable subsidiary on a practical example.

Assume that company A is the parent company, which acquired a 100% share in subsidiary Z on 31 December 2018. This is a cash contribution in the amount of € 800,000. The share capital of the subsidiary was also worth € 800,000. The share in the subsidiary was consolidated using the full consolidation method as at 31 December 2018 and 31 December 2019. Parent company A sold on 30 June 2020 the entire share in subsidiary Z in the amount of € 800,000. In 2019 and also in the first half of 2020, the subsidiary Z reported costs, revenues and profit. In our example, we will also abstract from liabilities and other components of assets. We assume that parent company A also has shares in other subsidiaries and thus carries out an activity that consists mainly in the ownership of financial assets.

In the tables we can see data from the individual financial statements of parent company A, data from the individual financial statements of subsidiary Z, consolidation adjustments, deconsolidation and finally the resulting consolidated data. [6] All data are given in thousand €.

Table 34. Consolidation as at 31 December 2018

Balance sheet	A	Z	Consolidation	Deconsolidation	Result
Total assets	2,800	800	- 800		2,800
Financial assets	800		- 800		
Cash	2,000	800			2,800
Equity	2,800	800	- 800		2,800
Share capital	1,200	800	- 800		1,200
Retained earnings	1,300				1,300
Profit + / Loss -	300				300
Income statement	A	Z	Consolidation	Deconsolidation	Result
Revenue	800				800
Expenses	- 500				- 500
Financial income					
Financial expenses					

Profit + / Loss -	300	300
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Source: own processing

In Table 1 we can see the first consolidation of capital as at 31 December 2018. In this case, it was the elimination of the financial assets of the parent company "A" and the share capital of the subsidiary company "Z". [3]

In Table 2 we see the consolidation of the subsidiary "Z" as at 31 December 2019.

Table 2. Consolidation as at 31 December 2019

Balance sheet	A	Z	Consolidation	Deconsolidation	Result
Total assets	3,200	1,000	- 800		3,400
Financial assets	800		- 800		
Cash	2,400	1,000			3,400
Equity	3,200	1,000	- 800		3,400
Share capital	1,200	800	- 800		1,200
Retained earnings	1,600				1,600
Profit + / Loss -	400	200			600
Income statement	A	Z	Consolidation	Deconsolidation	Result
Revenue	1,000	550			1,550
Expenses	- 600	- 350			- 950
Financial income					
Financial expenses					
Profit + / Loss -	400	200			600

Source: own processing

In the first step, we repeated the elimination of the financial assets of the parent company "A" and the share capital of the subsidiary company "Z". We repeated this step to maintain continuity. We also calculated profit or loss, while the subsidiary "Z" generated a profit of € 200,000. This profit is part of the consolidated profit or loss. The consolidated profit is thus a profit of € 600,000, which includes the profit of the parent company of € 400,000 and the profit of the subsidiary of € 200,000.

Table 3 includes information on the subsidiary "Z" as at 30 June 2020, because until then it was part of the consolidated group and this fact must be taken into account as at 31 December 2020. These data are very important for proper consolidation. The clearing data therefore also include the data of the subsidiary on the date of disposal, or

on the date of loss of control of the subsidiary by the parent company. Furthermore, Table 3 includes the data of the parent company "A" for the whole year 2020, in our case as at 31 December 2020.

Table 3. Consolidation as at 31 December 2020

Balance sheet	A	Z	Consolidation	Deconsolidation	Result
Total assets	3,500	1,200		- 1,200	3,500
Financial assets					
Cash	3,500	1,200		- 1,200	3,500
Equity	3,500	1,200	- 800	- 400	3,500
Share capital	1,200	800	- 800		1,200
Retained earnings	2,000	200			2,200
Profit + / Loss -	300	200		- 400	100
Income statement	A	Z	Consolidation	Deconsolidation	Result
Revenue	1,200	800			2,000
Expenses	- 900	- 600			- 1,500
Financial income	800				800
Financial expenses	- 800			- 400	- 1,200
Profit + / Loss -	300	200		- 400	100

Source: own processing

The first step we have taken is to repeat the consolidation of capital. We eliminated the item of the share capital of the subsidiary (amount of € 800,000), while we no longer eliminated the share in the subsidiary included in the financial assets, because at this date it is no longer part of the parent company's assets, as the parent company lost control as at 30 June 2020 over the subsidiary. The items of retained earnings, which in our case represent the value of € 200,000 and the profit for the first half of 2020, which also represents the value of € 200,000 are also part of the consolidated equity.

Now, we come to the part where we talk about deconsolidation. The difference between the assets of the subsidiary and the liabilities of the subsidiary reduced by the eliminated items of the equity of the subsidiary increases or decreases the financial cost of the parent company related to the sale of the share in the subsidiary. As we can see, in our case we eliminate assets in the amount of € 1,200,000 upon deconsolidation and the subsidiary did not have any liabilities, which means that the difference between the eliminated assets and liabilities remains € 1,200,000. If we reduce this difference by the eliminated share capital, which was € 800,000, we will have a difference of € 400,000.

We will subsequently reduce profit or loss by this amount and increase the cost of the sold share of the subsidiary.

The decrease in profit or loss is because the amount of € 400,000 includes the profit of the subsidiary for 2019 in the amount of € 200,000 and the profit of the subsidiary for the first half of 2020 also in the amount of € 200,000. Profit or loss of the sale of the parent company's share in the subsidiary is zero, because the sales for the sold share is € 800,000 and the cost of the sold share is the same, because it represents the purchase price of the sold share in the subsidiary. However, given that during the parent's control over the subsidiary, its equity increased by € 400,000, we can see that the consolidated financial statements show a loss from the sale of a share in the subsidiary of € 400,000.

In Table 3, we see the data in the consolidated financial statements, which include all data on the parent company. However, the retained earnings of the subsidiary as at 31 December 2019 are also taken into account here and the profit of the subsidiary as at the date of loss of control - as at 30 June 2020. Retained earnings of the parent and subsidiary as at 31 December 2019 amounted to € 1,600,000 and the profits of these companies for 2019 - the parent company for 2019 achieved a profit of € 400,000 and the subsidiary for € 200,000. The sum of these three amounts represents retained earnings in the consolidated financial statements as at 31 December 2020. Subsequently, we calculate the consolidated profit or loss. We calculate the profit of the parent company for the whole year 2020 (amount € 300,000) and the subsidiary for the first half of 2020 (amount € 200,000), while deducting the loss from the sale of a share in the subsidiary in the amount of € 400,000. This is a loss from the sale of a share in a subsidiary because the equity of the subsidiary at its inception was in the value of the deposit – in the amount of € 800,000. The equity of the subsidiary as at 30 June 2020 is in the amount of € 1,200,000. This means that the value of the sold share of the subsidiary was in the amount of € 1,200,000, but the sales for the sold subsidiary were in the amount of € 800,000. The difference € - 400,000 is reported as a loss, which is the difference between financial income and financial expenses, as we can see in Table 3. The costs and revenues in the consolidated financial statements also represent the costs and revenues of the parent company for the whole of 2020, while for the subsidiary it is only for the first half of 2020.

As mentioned, the subsidiary had higher equity at the time of the sale than at the time when the parent acquired the shares in the subsidiary. We can therefore talk about the loss of control of the so-called profitable subsidiary.

3.2 Loss of control of a loss-making subsidiary

About the loss of control, the so-called a loss-making subsidiary is involved if at the time of the sale, the subsidiary has a lower equity than it had at the time of the acquisition of the parent company's share in the subsidiary. The equity of the subsidiary has therefore ultimately decreased, a loss. [12]

In Table 4 we can see the first consolidation of capital as at 31 December 2018.

Table 4. Consolidation as at 31 December 2018

Balance sheet	A	Z	Consolidation	Deconsolidation	Result
Total assets	2,800	800	- 800		2,800
Financial assets	800		- 800		
Cash	2,000	800			2,800
Equity	2,800	800	- 800		2,800
Share capital	1,200	800	- 800		1,200
Retained earnings	1,300				1,300
Profit + / Loss -	300				300
Income statement	A	Z	Consolidation	Deconsolidation	Result
Revenue	800				800
Expenses	- 500				- 500
Financial income					
Financial expenses					
Profit + / Loss -	300				300

Source: own processing

Again, we eliminated the financial assets of the parent company and the share capital of the subsidiary.

In Table 5 we can see the consolidation of the subsidiary "Z" as at 31 December 2019.

Table 5. Consolidation as at 31 December 2019

Balance sheet	A	Z	Consolidation	Deconsolidation	Result
Total assets	3,200	650	- 800		3,050
Financial assets	800		- 800		
Cash	2,400	650			3,050
Equity	3,200	650	- 800		3,050
Share capital	1,200	800	- 800		1,200
Retained earnings	1,600				1,600

Profit + / Loss -	400	- 150			250
Income statement	A	Z	Consolidation	Deconsolidation	Result
Revenue	1,000	650			1,650
Expenses	- 600	- 800			- 1,400
Financial income					
Financial expenses					
Profit + / Loss -	400	- 150			250

Source: own processing

We repeated the elimination of the financial assets of the parent company and the share capital of the subsidiary. The consolidated profit or loss is a profit of € 250,000 which includes the profit of the parent company in the amount of € 400,000 and the loss of the subsidiary in the amount of € 150,000.

In Table 6 we see data for the parent company as at 31 December 2020, respectively for the whole year 2020, while the data of the subsidiary are only for the first half of 2020, respectively as at 30 June 2020, because as at 30 June 2020, the parent company lost control over the subsidiary

Table 6. Consolidation as at 31 December 2020

Balance sheet	A	Z	Consolidation	Deconsolidation	Result
Total assets	3,500	490		- 490	3,500
Financial assets					
Cash	3,500	490		- 490	3,500
Equity	3,500	490	- 800	310	3,500
Share capital	1,200	800	- 800		1,200
Retained earnings	2,000	- 150			1,850
Profit + / Loss -	300	- 160		310	450
Income statement	A	Z	Consolidation	Deconsolidation	Result
Revenue	1,200	600			1,800
Expenses	- 900	- 760			- 1,660
Financial income	800				800
Financial expenses	- 800			310	- 490

Profit + / Loss -	300	- 160	310	450
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Source: own processing

We repeated the elimination of the share capital of the subsidiary, while the elimination of financial assets that contain the share of the parent company in the subsidiary was no longer eliminated, as this share no longer exists as at 31 December 2020. The retained earnings are also part of the consolidated equity. The accumulated loss of the subsidiary is in the amount of € - 150,000 and the loss for the first half of 2020 is in the amount of € - 140,000.

Subsequently, we can perform deconsolidation. The difference between the assets and liabilities of the subsidiary reduced by the eliminated items of equity of the subsidiary will reduce or increase the financial expenses of the parent company, which is related to the sale of shares in the subsidiary. In our case, we eliminate assets in the amount of € 490,000 upon consolidation and this company did not have any liabilities, so the difference is € 490,000. We will reduce this amount by the eliminated share capital, which was € 800,000. We will have a negative difference € - 310,000. We will subsequently reduce the cost of the sold share of the subsidiary by this amount and increase the economic result.

The increase in profit or loss arises because the amount of € - 310,000 includes the loss of the subsidiary for 2019, which was in the amount of € - 150,000 and the loss of the subsidiary for the first half of 2020 in the amount of € - 160,000. As the revenues from the sold share of the subsidiary are in the same amount as the expenses of the sold share, the profit or loss from the sale of the share is zero. During the parent's control over the subsidiary, the subsidiary's equity decreased by € 310,000. The consolidated financial statements show a profit on the sale of a share in a subsidiary in the amount of € 310,000.

In Table 6, we see the data in the consolidated financial statements, which also include the data of the subsidiary up to the date on which the parent company lost control of the subsidiary. Retained earnings in the consolidated financial statements represent the sum of retained earnings of the parent and subsidiary as at 31 December 2019 in the amount of € 1,600,000, the profit of the parent for 2019 in the amount of € 400,000 and the loss of the subsidiary for 2019 in the amount of € - 150,000.

We calculate the consolidated profit or loss as follows: from the profit of the parent company for the whole year 2020, which represents the amount of € 300,000, we deduct the loss of the subsidiary for the first half of 2020, which represents the amount € - 160,000. It is a profit from the sale of a share in a subsidiary because the equity of the subsidiary at its inception was in the amount of the deposit, which represents the amount of € 800,000 and the equity of the subsidiary as at 30 June 2020 is in the amount of € 490,000. This means that the value of the sold share of the subsidiary was in the amount of € 490,000 and the sales for the sold share was in the amount of € 800,000, the difference in the amount of € 310,000 is reported as a profit. It is the difference between financial income and financial expenses. Other financial expenses and income items in the consolidated financial statements represent the expenses and income of the subsidiary only for the first half of 2020 and the parent company for the whole of 2020.

We see that the subsidiary had lower equity at the time of the sale than at the time the parent acquired the shares in the subsidiary, so we are talking about the loss of control of the so-called loss-making subsidiary.

4 Conclusion

In practice, the implementation of deconsolidation is very often incorrect or omitted altogether. It is a very complex process that the statutory auditor must oversee. [10] As the parent no longer has control over the subsidiary as at 31 December, this may lead to the subsidiary not being taken into account at all at that date, so that the parent and subsidiary data are no longer aggregated, no consolidation will take place. This may be because the parent no longer recognizes that interest in the subsidiary as a financial asset because it no longer has control over it. This may therefore lead to the complete omission of deconsolidation. However, this is a mistake, it is very important to take the subsidiary into account as of this date in order to carry out the consolidation correctly. [5]

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Participation of the Female Workforce and its Impact on the Economic Development of the Country

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Abstract. The labor market situation is complex and influenced by many unwritten and mostly unconscious norms and prejudices that apply to both women and men. However, more women in society pay for this setting. Firstly, by offering them a priori lower wages than equally qualified men (although "only" by women, the second thing is that more women than men work in human resources, so discrimination has a greater real impact) and secondly because men who perceive that they can be socially (less positively) and economically punished (more frequent dismissals) if they are not the best and if they prefer family and / or health if necessary will not be willing to promote a more equal distribution of responsibilities at home and in childcare. This in turn leads to a greater burden on women's unpaid work and slower career growth for women. A vicious circle is forming where the notion that domestic work and caring for children and other members of the household is a "women's" specialization persists, forcing women to combine family life with work and men to work earlier. career (although perhaps both would prefer a family-work balance). Such an approach has far-reaching consequences, not only economic but also psychological.

Keywords: Labor Market, Employment Rate of Women, Working Mothers, Costs per Employee

JEL classification: *J 24, J 11, O 15*

1 Introduction

In recent decades, we have seen a steady increase in the number of women in the global workforce. This trend is present in all countries of the world, both in the USA and in the countries of the European Union, with Slovakia being no exception. As Sadovská

(2020) says in Slovakia, however, we still have more working men (1.42 million) than women (1.17 million). However, the increase in the number of working women has an increasing trend, and over the last eleven years there has been an increase in the number of working women by 95,000, while the increase in the number of working men has been almost 45% smaller by 52,000. Entering the labor market, especially for women, is accompanied by an increasing challenge in reconciling work and family life, especially for those women who are also mothers. For this group, in addition to coordinating private and professional life, it is important to eliminate the risk of burnout, which can result from a double burden of work and domestic responsibilities. According to the Summary Report on the State of Gender Equality in Slovakia (2018), more and more women than men provide childcare and housework in EU Member States. In 2016 it was 92% women and only 68% men. In doing so, we take into account women aged 25 to 49 who have children under the age of 18. While the largest difference can be observed in Greece, the lowest difference in the share of childcare is in Sweden. In Slovakia, we can describe this share as significant, as only about 50% of men are involved in the care of households and children.

This situation is a challenge not only for the working mothers themselves and their partners, but there is room for the improvement of working conditions for this group of employees by companies as well as governments. Mothers with flexible working opportunities are a benefit not only for the companies themselves, but also for the world economy on a global scale. Their contribution to the labor market depends in particular on equality policy, which includes various legal entitlements, such as maternity leave, parental leave, the above-mentioned flexible working hours and various financial contributions from the state to support their natural return and integration into the labor market. Auster's (2001) research shows that a favorable work environment that promotes work-life balance has potential benefits for both employers and employees. When employees receive support from the employer in the workplace, they are able to balance work, private and family life, this is reflected in their overall self-realization and satisfaction, which ultimately have positive results not only for themselves but also for their employers in terms of increased productivity. Many of the economic improvements seen in middle-class families can be attributed to the increased earnings of women. According to the Center for American Progress (2019), in the United States, women's participation in the labor force and higher incomes for the economy increased by 13.5 percent between 1970 and 2013, an increase of \$ 2 billion. The effect resulting from the inclusion of mothers in the labor force is thus significant not only at the household level, but also from a macroeconomic point of view. The aim of the work is to point out the potential of the female workforce in the labor market, which is the goal of achieving economic growth. The adaptation of women to the labor market can be a key element of their competitiveness.

2 Low labor costs as a factor of Slovakia's competitiveness

Slovakia has a long-standing competitive advantage of cheap labor over other EU countries. However, given the rising labor costs, there are concerns that the country

could gradually lose this competitive advantage. From 2010 to 2018, labor costs per employee increased by four percentage points from 38% to 42%. Although this increase is significant, compared to the EU average, Slovakia's position has not changed significantly. We will look at this macroeconomic reality through the unit labor cost indicator. "The unit labor cost indicator (ULC) is considered to be one of the top additional indicators of the economy, and as such is quite often used (especially by foreign institutions) in assessing the economic development of individual countries, respectively, for a group of countries (euro area, E 25, E 15, etc.). This indicator links the overall output of the economy (GDP), labor productivity, wage and other labor costs (all in the ESA 95 methodology) and price developments, thus providing an overall view of the quality of economic growth." (Lipská & Vlnková & Macková, 2005)

The calculation of ULC at the national level is as follows:

$$\text{ULC} = \text{total cost per employee in nominal terms} / \text{real labor productivity} \quad (1)$$

$$\text{ULC} = \text{total cost per employee in nominal terms} / \text{nominal labor productivity} \quad (2)$$

$$\text{ULC} = \text{total cost per employee in real terms} / \text{real labor productivity} \quad (3)$$

Thus, unit labor costs show us and explain to us how employers' wage expenditures are growing in relation to labor productivity. Given the sharp rise in ULC, we can assume an imbalance in the labor market, resulting in future price pressures and a loss of producer competitiveness. Profit margins of companies are under pressure due to significant fluctuations in the unit labor cost indicator. It is thus a natural phenomenon that producers seek to maintain their profits by increasing prices and also by reducing investment or job creation. Unit labor costs in Slovakia have increased by almost 14% in the last eight years, which we still do not consider to be an extreme impact on Slovakia's competitiveness. Work as one of the factors of production is the basis for the production of goods and services. The goods and services produced in Slovakia are worth EUR 90.2 billion, of which 41% is accounted for by employees' wages. Taking into account labor productivity, we can say that one employed person in Slovakia produces goods and services worth EUR 37.3 thousand per year, and almost half of this value is the cost of this employee (i.e. 47%). In the European Union, this indicator is 56%, in some Member States even slightly higher - in Germany 57%. These values represent the well-known fact that Slovakia is a country that employs people with the ability to produce high volumes of goods and services, even with relatively low labor costs for these employees. The existing tensions in the Slovak labor market were reflected in the graph in the narrowing of the gap between Slovakia and the EU, although the differences between individual countries are still not significant.

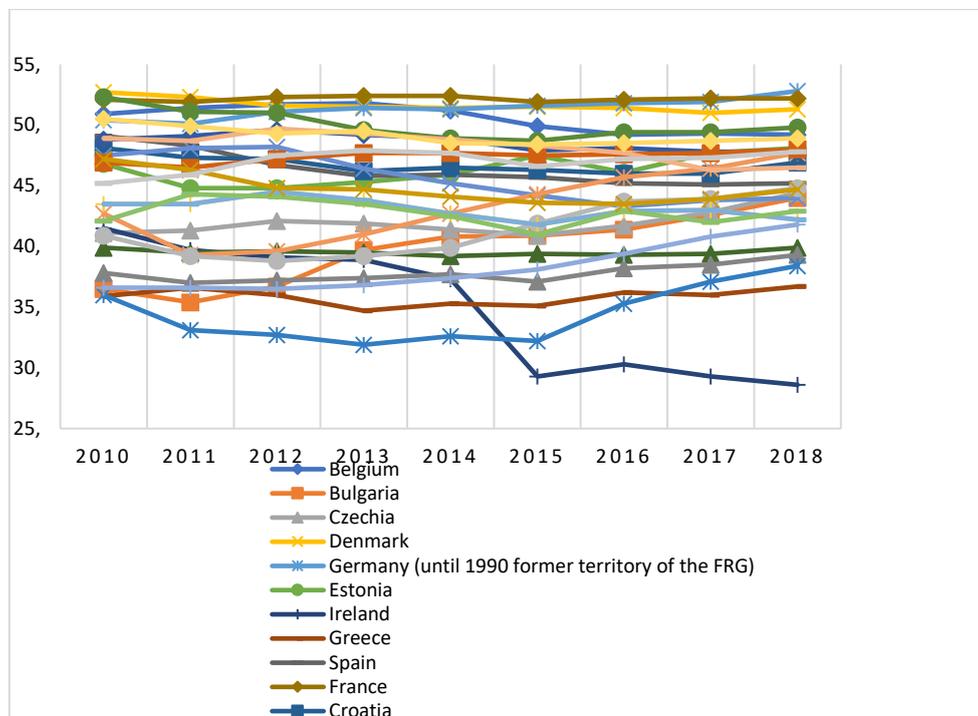


Fig. 19. Volume of labor costs in relation to GDP in the Slovak Republic and EU countries (in%, nominal quantities).

Source: Own processing according to data from the Eurostat

2.1 The current situation on the Slovak labor market from the point of view of gender equality

The competitiveness of each country depends on many known and lesser-known factors. The primary indicator is the performance of the economy, but it is backed by several years of efforts for proper education and the resulting growing human capital, which is the driving force of the Slovak economy. According to the above-mentioned statistics, it follows that the quality of future generations is increasingly ensured in an incomparably greater way in the family of women - mothers, all the more remarkable is the problem of gender inequality, which is present in all EU countries, with Slovakia no exception. The country should use its potential to the maximum extent possible, which means that all potential employees of productive age should also be included in the work process, as well as men, people with disabilities, immigrants, minorities, people with disabilities and also mothers, who are still disadvantaged and belong to a group facing disproportionately low employment rates. The report on creating a competitive EU labor market for the 21st century: matching skills and qualifications to demand and jobs as a way to overcome the crisis points to the fact that the European

Union still has great untapped economic potential for women, whose potential can contribute to economic growth. countries with the right support mechanisms from the employer and the state. According to the EU, it is necessary to create conditions for the possibility of career growth, building their own companies and holding middle and high management positions by women. First of all, it is necessary to eliminate the discrepancy between the achieved education of women and their subsequent inadequate position on the labor market. The European Union also points to significant inequalities in employment rates between men and women, with a difference of up to ten percentage points. "Achieving the employment rate target of 75% in line with the Europe 2020 strategy is conditional on increasing the employment rate of women through policies aimed in particular at reconciling work and domestic responsibilities," says the Report on Creating a Competitive EU Labor Market for the 21st Century (2015).

In addition to policies to promote the employment of women mothers, the European Union's priority is also to create jobs in areas of employment where there is a low, under-representation of women and in all management positions. At present, women are often better qualified than men, but they still hold jobs below their level of qualification. The paradox is the ubiquitous phenomenon of the risk of poverty and social exclusion affecting women who are cared for by another person, who may be not only children but also other dependent relatives. The fact that reconciling work and private life is becoming part of social policies and fundamental rights can be described as a positive development.

The labor market is characterized by sectors, activities and occupations dominated by women or men, also called horizontal segregation. Women's-dominated jobs are generally low-paid. Women often fill jobs in sectors where their work is less valued, ie lower paid than in those where men predominate. Women are twice as represented in health, education and public administration as men. When we look at the health and social work sector itself, about 80% of workers in this sector are women. Vertical segregation in the labor market is also a factor in determining the gender pay gap. In the same sector or society, women predominate in lower-paid, lower-paid jobs. Women are often employed as administrative assistants, saleswomen in shops or as low-skilled or unskilled workers - these occupations make up almost half of the workforce. Many women work in lower paid jobs (e.g. cleaning and nursing work). There are fewer women in decision-making positions, even in these sectors, where they are relatively well represented. And even if they fill these positions, they are in areas considered less important, or the scope of responsibilities is more limited. Women make up only 32% of company executives in the EU and 10% of board members of the largest companies. Overall segregation in the labor market leads to pay inequalities, as the value of jobs, which are mostly performed by men, is higher than the value performed by women. In Slovakia, we can historically attribute this development, for example, to the traditional division of gender roles.

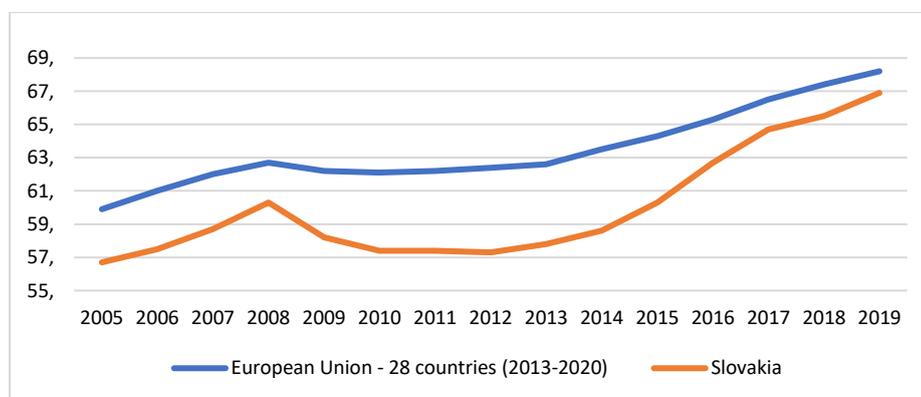


Fig. 2. Employment rate of women in the Slovak Republic compared to the EU average

Source: Own processing according to data from the Eurostat

2.2 Legal framework to support the female workforce

In addition to policies to promote the employment of women mothers, the European Union's priority is also to create jobs in areas of employment where there is a low, under-representation of women and in all management positions. At present, women are often better qualified than men, but they still hold jobs below their level of qualification. The paradox is the ubiquitous phenomenon of the risk of poverty and social exclusion affecting women who are cared for by another person, who may be not only children but also other dependent relatives. The fact that reconciling work and private life is becoming part of social policies and fundamental rights can be described as a positive development.

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The current legislation of the Slovak Republic is favorable for women who are interested in adapting to the labor market. It takes into account women's specifics from different angles and from the point of view of their social status, which is closely connected with the role of motherhood. The legal framework of the Slovak Republic contains the following protection of women in labor relations:

- Labor Code - women must not be employed in positions that could be physically inappropriate for them and endanger their maternal mission, but at the same time it does not enshrine jobs that the Labor Code would prohibit for women. Furthermore, pursuant to §64 para. employee caring for a child under three years of age.
- Adjustment of working hours - when assigning workers for changes, the employer is obliged to take into account pregnant women and women caring for children, the employer is also obliged to comply with a woman caring for a child under 15 years of age when requesting adjustment of working hours, unless prevented by serious operating conditions. reasons
- Overtime work and on-call time - a pregnant woman and a woman caring for a child cannot be ordered by the employer on-call time, this is only possible in agreement with the employee
- Night work - a pregnant woman and a woman who has a child under the age of nine months must be transferred by the employer to work other than night work
- Breastfeeding breaks (§ 166 - § 170 of the Labor Code) - in addition to the standard breaks stipulated by law, the employer is obliged to provide the breastfeeding mother with special breastfeeding breaks
- Pregnant women, mothers up to the end of the ninth month of childbirth and nursing mothers - Lists of works and workplaces that are prohibited for pregnant women, mothers up to the end of the ninth month after childbirth and breastfeeding women are regulated by Government Regulation no. 272/2004 Coll., Which establishes a list of jobs and workplaces that are prohibited for pregnant women, mothers until the end of the ninth month after childbirth and breastfeeding women

3 Conclusion

According to the consulting company PwC, Slovakia ranks 26th out of 33 OECD countries in terms of women's employment. Pavúková (2020) says that according to this study, increasing women's employment to the level of women's employment in Sweden would help Slovakia increase GDP by 7.8%. The increasing employment of women leads to an overall better economic position of women, which thus depends not only on the level of women's income but also on the very initial adaptation of women on the labor market. When deciding to return to work, a woman must take into account her own needs as well as the needs of her family. However, one thing still applies to the country that working mothers are central to the nation's economic growth, the development and maintenance of healthy communities, and the financial security of

their families. Adequate investment in childcare is vital for the economic, physical and emotional health of families and communities. This is true at the individual level, given the central role that most mothers play in families in providing and coordinating care. However, this is also the case in the context of the wider community, as working mothers of young children are likely to find employment in sectors that help support the education, care and employment of other families. Without the paid work of working mothers, the normal functioning of state economies throughout the country would come to a halt. Nevertheless, too many working mothers face difficulties in providing childcare, better access to which would allow them to remain employed. As a result, many mothers reduce their working hours, change jobs or leave the labor market altogether to meet and care for their children's needs. However, this hampers overall economic growth and, from a microeconomic point of view, the well-being of the family. Therefore, any sound economic strategy to ensure a prosperous, strong and stable economy must take into account the considerable driving force of the female population and maximally support the increase of the employment rate of women in Slovakia and the removal of barriers to women's entry, especially for women who also care for women. children, the labor market.

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Perception of housing quality and the current situation on real estate market by Generation Z

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Abstract. The next generation will socially and economically create the image of Slovakia. Understanding the consumer behaviour of this generation is therefore becoming increasingly desirable. The article focuses perception of the housing quality and current situation on real estate market by next generation in Slovakia. Within this article was used standardized questionnaire via Google Form. A total of 115 respondents took part in the research. The respondents were from the Faculty of Commerce at the University of Economics in Bratislava and studied in the final year of the master's degree. The obtained answers of the respondents were subsequently processed using ANOVA one-way-test. From the overall point of view the 81.74% of respondents from the total number, perceive their housing quality positively. The results explain a strong agreement with the perception of the house quality among respondents. Nevertheless, we can record negative perception of the current situation on real estate market by 50.4% of the respondents. We also note the negative perception of current housing legislation by 71.3% of respondents. At the end of the article is the formulated responses of the results by the Generation Z in solving questions of housing from the demographic perspective of gender structures and residence of respondents.

Keywords: Quality of housing, Real estate market, Consumer behavior

JEL classification: R 21, R 30, M 31

1. Introduction

Satisfying the need for housing has become a society-wide desirable task for the company's future growth. Housing is a basic human need and a social right, the aspects of quality and affordability of which are among the evaluation attributes of the living standards of a given country's population. The development of socio-economic characteristics creates good opportunities for population development and, thus, housing opportunities. The creation of favourable conditions for the population ensures the necessary result of the community itself. Although housing is one of the social rights and basic human needs, its availability and quality may not be adequate. The changing society and market are creating new challenges to meet housing needs.

However, due to the specificity of the individual, we cannot cover the entire cohort or the entire generation. Shuman and Scott's 1989 research confirmed previous expectations that within a generation, if a significant historical event occurs, it will most affect a particular group of most affected people. From this point of view, the cohort is closely linked to the event, which creates a natural target group for marketers (Schewe & Meredith, 2004). The reason for a closer scientific examination of the issue of generations, the authors do not know precisely how to classify and time-limit individual generations (Karashchuk et al., 2020). According to the general definition by Strauss & Howe (1991), the generation alternates over time after 20-year cycles. However, other authors classify generations in 10-year cycles, and only at the end of the 20th century do they characterize generations in 20-year cycles or reverse order. It all depends on the cultural and regional differences in the specified areas.

For this reason, there is no comprehensive uniform time and classification line of the studied cohorts and generations in the scientific community. At the same time, some studies deny some characteristics and characteristics of generations based on historical events. These studies define cohorts and generations based on technical progress (Watcom Group, 2018). There is also criticism of the definition and use of coherent cohorts within generations in theory and practice (Rudolph et al., 2018). At present, people from the cohort, called Generation Z, are coming to the fore regarding socio-economic perception. Agreement in the scientific community. A vital attribute of the cohort studied is their propensity for success and the factors that ensure this. At the same time, housing and its quality is an essential aspect of their future development.

Rapoport (1969) perceives housing from the point of view of a cultural phenomenon. This view includes the architectural construction of the house itself, which belongs to a comprehensive cultural whole of the environment and community. This creates a whole that, in addition to the primary passive function of protection, also includes a positive function that creates an internal environment that suits its inhabitants and an external environment that forms a neighbourhood or community (Rapoport, 1969). We can also perceive housing itself as an economic commodity with market value and tradable. Housing reflects a person's economic status and availability to achieve a certain quality of life. The economic perception of real estate must be closely related to housing quality. Based on the median affordability (median price-to-income ratio), it was found that cities in less developed countries are significantly less accessible (by 28%) than cities in more developed countries (Lincoln Institute of Land Policy, 2018). The deepening differences between the strata of people are causing the increasing unavailability of quality housing. This is confirmed by McKinsey's research (2014), which estimates that up to 330 million urban households' lived-in poor-quality conditions or financial distress from paying housing fees. The research also assumes an increase in such households to 440 million—1.6 billion people by 2025. By 2050, people living in such conditions should increase to 2.5 billion people (Woetzel, 2014). Satisfaction with housing is perceived by the author Oreský (2019) as: "*as a subjective assessment based on the overall perception of what a person considers to be an essential element of living in the environment in which he lives*" (Oreský, 2019).

A closely linked relationship with housing has the health of the population. Many studies have examined population health and housing conditions, with several findings strongly linking poor health to poor housing (Carnemolla & Bridge, 2016). Some

findings suggest that population health interactions are also influenced by housing type, density, and street layout. These factors also affect trust, social cohesion and the team, and the overall sense of community, whose functions have a significant impact on mental health (Pearson et al., 2014).

Quality housing is the focal point of a productive, healthy, and meaningful life. Author Baker (2016) perceives housing as having a fundamental impact on material living standards. It influences people's basic requirements, such as protection and shelter from the volatile local climate, creating a sense of privacy, security, and enclosed space. The social determinants of health and well-being are also influenced by housing conditions (Baker et al., 2016).

The perception of the value of housing by the new generation has become an important part of the development of society, and therefore it is necessary to have more attention to this research.

2 Methodology

The aim of the article is to express the perception of housing quality and the perception of the current situation in real estate market by Generation Z. We will achieve the chosen goal using several scientific methods. It is necessary to use secondary research, which the author's primary research will supplement. The knowledge of professional, scientific literature will be used within the secondary research. We will then process the knowledge we need to be based on the general basis of scientific methods - abstraction, selection, analysis, synthesis, induction, deduction, and comparison. The acquired knowledge will then be processed based on logic and mathematical-statistical methods. We will also use primary research to cover the chosen goal. The primary research took place in March and April in 2021. It was attended by 115 respondents working in the final year at the Faculty of Commerce at the University of Economics in Bratislava. Respondents were selected based on a variable - age to include the cohort of people we selected. The primary research was conducted using an electronic questionnaire using the Google Form platform. The questionnaire was divided into five separate parts. The questionnaire itself consisted of 44 questions, of which 20 scales, 7 polynomial questions, 6 dichotomic, 6 classification questions, 2 selective questions, 2 dialogue questions and 1 multiple-choice question. The obtained data were processed using the general basis of scientific methods and mathematical-statistical methods, using the ANOVA one-way-test. ANOVA one-way-test was processed in Microsoft Excel. For better understanding, these statistics were presented graphically in tables and graphs. The article contains seven tables. The results are graphically described in Table 2.

To better define this group of respondents, we characterized them in more detail according to demographic variables in Table 1.

Tab. 1 Definition of respondents to the survey according to the demographic variable

Gender:		Working status:		Residence:	
Female	64.3%	student (non-economically active person)	25.2%	Bratislava Region	35.7%
Male	35.7%	student (full-time job)	7%	Trnava Region	13%
		student (part-time job)	37.4%	Trenčín Region	4.3%
		student (internship)	10.4%	Nitra Region	11.3%
		student (half time job)	3.5%	Bánska Bystrica Region	11.3%
		student (self-employed)	20.9%	Žilina Region	11.3%
		graduated (employment)	13%	Prešov Region	10.4%
		graduated (non-economically active person)	3.5%	Košice Region	2.6%

Source: Author's own processing based on data from primary research (2021)

The ambition of this article is to answer the author's hypothesis (H) and research question (RQ), which will be examined using the ANOVA one-way-test:

H: There is a relationship between housing quality assessment and perception on current situation on real estate market in Slovakia.

RQ: How do respondents based on gender structure perceive their quality of the housing and current situation of real estate market in Slovakia?

In the final part of the article, the answers obtained will be used to achieve the main goal of the article and to evaluate the quality of the housing and current situation of real estate market from the demographic variables of gender and residence structure of Generation Z.

3 Results and discussions

3.1 Evaluation of examined hypothesis and research question

Using the standardized questionnaire, the article's author evaluated the perception of the housing quality that prevailed for the examined generation via perspective of demographic variables – gender and residence. In a standardized questionnaire, the

author focused on finding out the perception of the quality of previous housing, housing issues, possible ownership conditions and the method of acquiring real estate. In the next part, the author focused on the evaluation and perception of the current development of the real estate market, its attributes, and its activities. Subsequently, this information's were process within the following hypothesis and research question. The hypothesis was tested by ANOVA one-way-test and was graphically described in Table 2. In Table 2 are recorded P-Value, Alpha, F-Value, F-critical, as well as differentials of measured values. These presented values are the main values of ANOVA one-way-test analysis.

Tab. 2 Result of chosen author's hypothesis using ANOVA one-way test

	F- Value	F-Critical	F> F-Critical	Alpha	P- Value	Alpha > P- Value
H1	120,3374	3,035617	F> F-Critical	0.05	2,35E-36	Alpha > P- Value

Source: Author's own processing based on data from primary research (2021)

The data presented in Table 2 represent an essential part of answering the author's hypothesis and research question in the study of consumer behaviour of the selected cohort Z in housing quality and the current real estate market.

H: There is a relationship between housing quality assessment and perception of the current situation on real estate market in Slovakia.

The results presented in Table 2, which define the key values of the ANOVA one-way-test analysis (F> F-Critical and Alpha> P-value), confirm the author's hypothesis. We can thus reject a possible random phenomenon and confirm the author's hypothesis.

RQ: How do respondents based on gender structure perceive their housing quality and the current situation of the real estate market in Slovakia?

In the primary survey, respondents were asked selective, multiple-choice, polynomial questions and a 5-point Likert scale to assess their perception of housing quality. Using a 5-point Likert scale, we can determine their perception in the area of housing quality based on a variable - gender in Table 3.

Tab. 3 Perception of the parameter housing quality according to the respondents based on the demographic variable - gender

Factors / Gender	Female Σ74 respondents	Male Σ41 respondents
Strongly positive	55.41%	34.19%
Positive	25.68%	48.8%
Neutral	13.51%	17.01%

Negative	4.05%	
Strongly negative	1.35%	

Source: Author's own processing based on data from primary research (2021)

From survey results, we note a positive perception of the quality of housing in all respondents. From the overall point of view, up to 94 respondents, representing up to 81.74% of respondents from the total number, perceive their housing quality positively. From the point of view of female respondents, it is up to 60 respondents, representing 81.09% of the total number of female respondents. For male respondents, up to 34 respondents perceived their housing quality positively, representing 82.99% of the total number. The fact is that only 4 respondents perceived their quality of housing negatively among female respondents, which represented a level of 5.4%. From the second point of view, we did not observe the studied phenomenon in men. To further characterize the examined metrics, we decided to divide the respondents according to another demographic criterion residence of respondents' housing and the permanent criterion - gender of the respondent.

Using the 5-point Likert scale, we were able to determine the intensity of the impact, where we can quantify the investigated intensity based on the strength of the perceived parameter of housing quality. In simplicity, it can be stated that a higher score indicates a higher intensity of housing quality. The key values of this analysis - Cronbach's alpha, standard deviations and average measured values were analysed for each gender and their place of residence separately, and we recorded them in Tables 4, 5. The performed analysis was processed in Microsoft Excel.

Tab. 4 Quality of housing of female respondents from specific regions

	Average measured value	Standard deviation	Cronbach's alpha**
Bratislava Region	4.231	1.225	0.711
Trnava Region	4.7	0.233	0.950
Trenčín Region	4.5	0.333	0.926
Nitra Region	4.2	0.7	0.833
Bánska Bystrica Region	4.286	0.571	0.867
Žilina Region	3.667	1.75	0.523
Prešov Region	4.636	0.255	0.945
Košice Region	4	2	0.5

Legend: * Used 5-point Likert scale (5 = strongly agree, 1 = strongly disagree)

**Total Cronbach's alpha = 0.11

Source: Author's own processing based on data from primary research (2021)

Tab. 5 Quality of housing of male respondents from specific regions

	Average measured value	Standard deviation	Cronbach's alpha**
Bratislava Region	4.429	0.418	0,906
Trnava Region	4.2	0.2	0,952
Trenčín Region	3.5	0.5	0,857
Nitra Region	4.286	0.571	0,867
Bánska Bystrica Region	3.833	0.567	0,852
Žilina Region	4.333	0.333	0,923
Prešov Region	4	2	0,5
Košice Region	3.5	0.5	0,857

Legend: * Used 5-point Likert scale (5 = strongly agree, 1 = strongly disagree)

**Total Cronbach's alpha = 0.06

Source: Author's own processing based on data from primary research (2021)

The data expressed in Table 4 explain a strong agreement with the perception of the quality of housing among female respondents. The average measured value of all female respondents represents 4.2775, which strongly confirms agreement with housing quality. We also notice this phenomenon among male respondents, where we also have a strong agreement with the perception of housing quality. The average measured value of all male respondents represents 4.010, which strongly confirms agreement with housing quality. From a comprehensive point of view, we recorded a strong positive perception of the current housing quality by respondents in the survey. However, we must emphasize that only 18 respondents, represent 15.65% of respondents of the total own property. Of these, only 12 respondents acquired the property by direct purchase and not by donation or inheritance. From a statistical point of view, the average measured value of the housing quality attribute for all property owners is around 4.444. We noted a strong positive perception of the quality of housing among respondents, including those who live with their parents or rented those who already own real estate.

Tab. 6 Assessment of the real estate market by respondents via gender

Factors / Gender	Female $\Sigma 74$ respondents	Male $\Sigma 41$ respondents
Strongly positive	2.71%	-
Positive	6.76%	7.31%
Neutral	44.59%	34.15%
Negative	33.78%	34.15%
Strongly negative	12.16%	24.39%

Source: Author's own processing based on data from primary research (2021)

Tab. 7 Assessment of the real estate market by all respondents from specific regions

	Average measured value	Standard deviation	Cronbach's alpha**
Bratislava Region	2.61	0.844	0.323
Trnava Region	2.334	0.524	0.224
Trenčín Region	2.31	0.897	0.389
Nitra Region	1.6	0.8	0.5
Bánska Bystrica Region	2.385	0.923	0.387
Žilina Region	2.231	0.526	0.236
Prešov Region	2.583	1.174	0.455
Košice Region	3	1	0.334

Legend: * Used 5-point Likert scale (5 = strongly agree, 1 = strongly disagree)

**Total Cronbach's alpha = 0.36

Source: Author's own processing based on data from primary research (2021)

Part of the primary research was to measure the intensity of the impact of the current real estate market on the cohort under study. From the point of view of what we can characterize, the current generation perceives negative the current development of the real estate market. We observe the data in Table 6 for female respondents. Only 9.47% of female respondents have a positive perception of the current real estate market. It negatively perceives up to 45.94% of women's respondents. We also asked respondents about regular monitoring of the real estate market. The results showed that up to 48 female respondents regularly monitor the real estate market development, representing 64.86% of the total number of female respondents. Interestingly, 27 female respondents, representing 36.49% of the total number of female respondents who regularly monitor the development of the real estate market, perceive the real estate market in Slovakia as a whole. When characterizing data for male respondents, we note a strong negative reaction to the current state of the real estate market. Negative perception of the current real estate market up to 58.54% of male respondents. The real estate market development is regularly monitored by 27 male respondents, representing 65.85% of the total number of male respondents. Of these, up to 21 male respondents, representing 51.22% of the total number of male respondents, perceive the overall state of the real estate market negatively. Respondents who own real estate regularly monitor the development of the real estate market while perceiving it negatively and the currently set legislation of the housing policy of the Slovak Republic. The average measured value of all respondents represents 2.381, which negative confirms agreement with situation on real estate market in Slovak republic.

This phenomenon was also confirmed in the following aspect focused on the perception of housing legislation by respondents. For both genders, we noted a negative perception of satisfactory legislation in the area of housing policy. Within female respondents, we recorded up to 70.27% negative perceptions of compliant legislation, and among male respondents, we recorded up to 73.17% negative perceptions of compliant legislation in the area of housing policy. Overall, we see a negative perception of the real estate market by the upcoming generation.

Conclusion

Despite the ongoing pandemic in the world and in our country, when socio-economic activities have been limited, we see a positive perception of the quality of housing in the surveyed respondents. From the overall point of view, up to 94 respondents, representing up to 81.74% of respondents from the total number, perceive their housing quality positively. From the point of view of female respondents, it is up to 60 respondents, representing 81.09% of the total number of female respondents. For male respondents, up to 34 respondents perceived their housing quality positively, representing 82.99% of the total number. The fact is that only 4 respondents perceived their quality of housing negatively among female respondents, which represented a level of 5.4%. On the other hand, with the ongoing pandemic, the real estate market trend in terms of price growth has not slowed down significantly in Slovakia. This creates a strong paradigm when the recorded deteriorating socio-economic conditions did not slow down this growth and deepened the problem of housing in Slovakia. This fact was also confirmed by the results of the perception of the current set legislation in the field of housing. Within female respondents, we recorded up to 70.27% negative perceptions of compliant legislation, and among male respondents, we recorded up to 73.17% negative perceptions of compliant legislation in the area of housing policy. We found that, only 9.47% of female respondents positively perceive the current real estate market. It negatively perceives up to 45.94% of women's respondents. On another side, the 58.54% of male respondents negatively perceive the current real estate market. The development of the real estate market depends on many factors (ECB policy, country housing policy, housing legislation, construction incentives, state social policy, current and planned real estate construction, current prices of materials and workers, etc.). Overall, these factors form the picture of the current real estate market. To improve the conditions of the real estate market and the overall development, it is necessary to improve the mentioned factors and to support programs aimed at supporting young people and their first housing. Due to insufficient support, low construction, low interest rates of financial institutions, high demand from people, or inflexible legislation, this phenomenon will continue to deepen, and real estate prices will rise. Housing is generally one of the European Union's most important players. The increasing pressure from the European Union creates the necessary attributes, which after the subsequent application, can speed up the mentioned process.

Due to a better understanding of research needs in the perception of housing quality and the current situation on the real estate market, we included the selected sample in cohort of Generation Z. However, based on this, we cannot generalize these results for the whole cohort of Generation Z living in the Slovak republic. Nevertheless, we can take the results of the survey as a point for a closer examination of the issue of housing in Slovak republic by the next generation.

The housing quality has recently gained a high level of interest in several scientific, private, but mainly in public institutions. The reason for this popularity is its broad-spectrum concept and use in several scientific and professional fields. Its scope can be used in both the human, natural and technical sciences. There is an intersection between several directions because understanding this issue from only one direction

creates an imaginary bubble, the essential characteristics of which can be described but not its essence. For this reason, it is necessary to penetrate several scientific methods and several subjects across the entire spectrum. As this issue directly concerns the person himself. The need for housing or protection is the basic choice of every person, and therefore their quality is directly linked to the very quality of life of that person. Securing a home has naturally become a duty that one strives to achieve in the highest possible quality throughout one's life. The current growth of the cohort representing Generation Z creates broad-spectrum opportunities for us to understand this issue from the point of view of housing. Therefore, the best possible understanding of the interests, influencing factors, expectations, the intensity of decision-making, and the decision-making process of this cohort as a future bearer of socio-economic, technological, political, and demographic phenomena is needed.

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Digitalization and COVID-19 in the Justice Sector

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Abstract. The digitization of society has significantly changed the tools that society uses in all aspects of life. One of them is the judiciary sector, where it has moved significantly from emails to video conferencing or from electronic files to blockchain. On the one hand, COVID-19 demonstrated possible improvements and led to the streamlining of activities in the judiciary, but on the other hand, it also showed significant differences between countries in their digitization progress. One of the recommended solutions to improve digital services is to increase the budget. Our correlation between the results of the ICT development index in courts and the percentage of ICT expenditure in courts shows that this factor is not sufficient. At the same time, it turns out that although the justice department is a subset of public administration and e-justice is a part of e-government, there is no visible relation between them in the results of the various indices. A prerequisite for the implementation of e-justice is not only expenses for ICT, but also user education, i.e., court staff, which are complementary to each other. Ensuring the availability and fairness of the justice administration is an important factor in the rule of law that affects the perception of the country among investors.

Keywords: e-justice, COVID-19, digitalization, ICT, e-government.

JEL classification: K40, D80, H41

1 Introduction

“The internet is the defining technology of our age. Connectivity and information are utilities, like electricity or water, that touch and influence every aspect of modern life.” [7]

The demand and supply of digital government services is constantly growing as the number of internet users increases. This growth has also been developing since before COVID-19. Although the rise in the number of internet users (by 10,7 %) was in line with the growth in users of e-governance services (by 10,4 %) in the last 6 years in EU,

the number of internet users accounts only for 85,3 % (2019) the number of e-government users is just 67,3 % (2019) [10] [11].

Moreover e-justice has a specific position within e-government. It is an essential part of electronic administration in the field of justice when we talk about the formation of its modern public version. E-justice can be found under the more general umbrella term of e-government [4] and is a component of a comprehensive e-government system [32].

Information and communication technology (ITC) for courts is for:

- the back office (as a support for the processes that relate to the case administration, document production and court management),
- the external communication (as a communication channel with judicial parties and the external environment) and
- the courtroom (as a support and way to check the process in the courtroom) [30].

ICT has spread widely, becoming an element often budgeted for and integrated in many courts' activities, procedures, and practices. The European Commission for the Efficiency of Justice (CEPEJ) stated in 2006 that, although huge efforts are being made and financial resources are being used in ICT, the use of ICT often fails to bring the efficiency, productivity gains and service improvements that have been promised. At the same time, it points out that once technologies are in place, they need to be maintained, as applications need to be updated quite often in the light of legislative amendments [21]. These conclusions are also relevant in 2021.

The use of ICT can strengthen justice systems and make them more accessible, efficient, resilient and ready to face current and future challenges [14]. Digitization has definite positive effects, but it certainly also has negative ones. An example for this is a study that has shown that 50% of applicants heard via video link were refused bail, compared to 22% of those heard in person [33]. The increased use of digital tools in the justice sector should not be an obstacle but a tool to increase fairness [14].

The well-progressed development and proper use of ICT is an important element of well-operating judicial systems [20]. Efficient judicial systems have a positive impact on the growth rate of turnover and the growth rate of the number of firms [2]. The well-functioning judicial system relates to higher independence, which can increase the average turnover growth rate, productivity [2] and foreign direct investment inflows [3]. Good governance, including the rule of law can help long-term inclusive growth [23]. But we must remember that the efficiency of an institutional structure is not a reason but a result of growth [28].

One of the factors affecting the extended length of court proceedings (thus influencing the effectiveness of justice) is that a larger share of the justice budget is devoted to the ICT of courts. However, Contini and Cordella show that ICT is not a universal remedy to achieve fair justice in reasonable time. Many more organizational factors need to be addressed [5] [6]. Nonetheless, larger shares of the justice budget for automation are associated with better judicial performance [26].

The development and progress of ICT in courts can be monitored through the evaluation of CEPEJ, when the evaluation from 2006 (data 2004) quantifies ICT in courts through tools such as emails, electronic files, etc. [21], but the European

Commission's ICT evaluation from 2020 (data 2019) in courts via blockchain, video conferencing or artificial intelligence [16] [14]. CEPEJ already prepared principles of the Ethical charter on the use of artificial intelligence in judicial systems and their environment [15] and on the EU level is The E-Justice Strategy and Action Plan 2019-2023, in which artificial intelligence and blockchain in the justice field are identified as priority areas [9].

1.1 COVID-19

The justice system in any country plays an important role in COVID-19 crisis because it must be protected and be ready to protect people (domestic violence, job losses, evictions etc.) and firms (bankruptcies, debt etc.) in specific situations, which occur during crisis [29]. The well-prepared judicial system will protect the weaker parties and ensure justice, so the rule of law should be followed as well.

A significant rise in litigation is expected related to

- The business: An increase in commercial disputes is expected due to breach of contract. Labour disputes are anticipated because of redundancies and bankruptcy of employers. Another area that would be affected may be litigation due to tax obligations, which may be caused by disputes over the tax applications of financial benefits from the state during the lockdown [29].
- The unemployment: The unemployed will dispute the protection of their employment contract, social benefits, or other unemployment benefits [24].
- The women and children: Domestic violence against vulnerable populations is expected to increase during the pandemic. At the same time, due to the financial problems of households caused by job losses, the rate of evictions is expected to increase as well [27].
- The consumer: The number of consumer disputes will increase due to the postponement of holidays, border restrictions or increased online shopping [24].

This type of health crisis may be repeated. The CEPEJ prepared the following important principles that can help during crisis and not only protect the law, but also protect the people, who work in court:

- Human rights and rule of law must be always protected, especially during a crisis.
- Access to justice (the access must be maintained as much as possible).
- Safety of person (teleworking as a solution).
- Monitoring case flow, quality, and performance (case management systems and mechanisms of statistical data collection).
- Cyberjustice (reducing the cybersecurity risks).
- Training (new curricula to support the justice professionals during and after a health crisis, including IT training).
- Forward looking justice (implement new long-term solutions for the crisis) [20].

Because of these five out of seven principles which relate to ICT in justice, it is possible to see how important ICT in justice is in the 21st century.

2 Methodology and variables

Based on the initial theoretical framework on ICT in justice, we have defined several hypotheses, which we tested in the next section. We used the correlation function and the standard deviation function.

H1: There is a strong correlation between courts' expenditure on ICT and the ICT court index.

H2: The results of states with e-government influence e-justice.

H3: Positive impact of COVID-19 on e-justice.

Relevant dates about digitalization, which is important during COVID-19, are from:

- EU Justice Scoreboard and
- CEPEJ Evaluations Report

CEPEJ has been collecting data on the computerization and electrification of on behalf of the Council of Europe countries every two years since 2006. It also collects data on courts' expenditure for digitization. At the same time, the European Commission also processes data from the CEPEJ and creates a special report about the evaluation of the justice systems in EU countries. In 2020, the European Commission collected data on digitization, which was needed for the operation of the courts during COVID-19. To test the correlation between e-justice and e-government, we used data on the digitization of public administration from the UN, the OECD, and the EU. Due to data availability issues, we only used data for all CEPEJ countries in the case of the correlation between ICT expenditure and the ICT development index. In other cases, we used data only for EU countries.

The data on developments in justice in Slovakia during COVID-19 in 2020 was published by the Ministry of Justice of the Slovak Republic.

3 Results

To analyse the impact of the court budget on ICT regarding digitization results, we chose data from the ICT index and the share of ICT spending on the court budget. In 2020, CEPEJ published data on the ICT Development index in justice for the first time (data 2018), which combines results on digitization in the following areas of justice: development rate, communication with courts, courts and case management, decision support in civil, administration and criminal cases.

ICT spending needs a longer period to translate into practice, so we use the years 2014 and 2015. By analysing the relationship between expenditure on IT and the ICT index, we can observe that the variables have a negative correlation (- 0,05). It means that the rising costs of digitization slightly reduce the impact of it (Fig. 1).

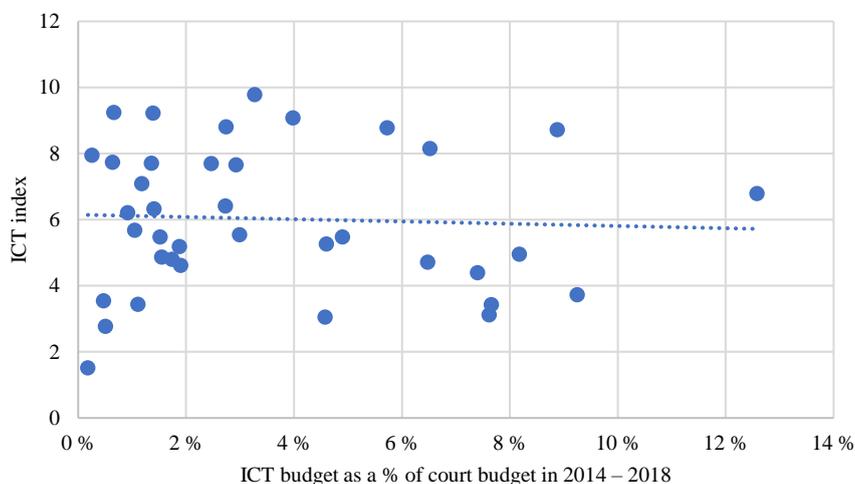


Fig. 20. Correlation between ICT budget as a % of court budget in 2014 – 2018 and ICT index in 2018

Data source: [16].

The same results were confirmed in the previous years, 2010, 2012 and 2014, when the values of the correlation parameter were close to zero, so there was no correlation between ICT expenditure and ICT results [17] [18] [19]. The reason for this zero correlation between variables may be, for example, that countries use significant financial resources to maintain existing systems without developing new and modern ICT. Another possible reason may be that, although they invest in ICT, they also invest in other areas of justice than those pursued by CEPEJ.

The challenge for each country is not only to have a sufficient ICT budget, but also to provide sufficient training for ICT judges, as the two areas complement each other [26]. Although the average ICT training for judges in 2016 – 2019 was between 23,8 – 25,5% (share of continuous training of judges on various types of skills), up to four countries (EU 27) in the given period reported 0 % of training in ICT skills.

A positive relationship between e-government and e-justice is to be expected because e-justice is another part of the digitalization of public administration. However, the results of the correlations show that there is a very weak positive correlation between the digitalization indices of public administration. The same results are confirmed in relation to the idea of telecommunication infrastructure or the idea of online services. There is a medium correlation between the results of the correlation between ICT justice and ICT tools during COVID-19. It follows that individual states must focus on specific investments in ICT in the courts and it is not possible to rely only on general investments in electronic public administration or vice versa.

Table 35. Correlations between ICT justice index and selected indexes

organization	UN	UN	UN	UN
name of index	E-Government Index	E-Participation Index	Online Service Index	Telecommunication Infrastructure Index
correl	0,26	0,15	0,30	0,15
organization	OECD	EU	EU	EU
name of index	E-gov index	ICT tools during COVID-19	The Digital Economy and Society Index	The Digital Economy and Society Index - Digital Public Services
correl	0,10	0,69	0,11	0,18

Data sources: [34] [10] [25] [12].

3.1 COVID-19

Most EU Member States use digital solutions, which were also useful during COVID-19. At the same time, however, COVID-19 also brought new challenges in the digitization of justice, to which individual states have already contributed and must do so further.

Digital tools played a major role during the COVID-19 waves, as they allowed litigants to communicate with the courts, continue hearings, supplement evidence, or render judgments. These tools have made it possible not only to continue working, but also to save the costs associated with a physical participation in hearings or postal services.

The data shows that countries were ready to provide evidence filed in a digital form. Nevertheless, they were insufficiently prepared for the challenges of distance communication, and especially had trouble conducting the oral part of the procedure entirely via distance communication technology. Figure 2 shows that there are differences in countries' approaches to e-justice. The most trivial difference can be found in the case of digital access to court proceedings; for instance, when the electronic acknowledgment of the receipt proving submission of documents with the court is needed. A negative example is again distance communication in which the most significant differences between countries can be found.

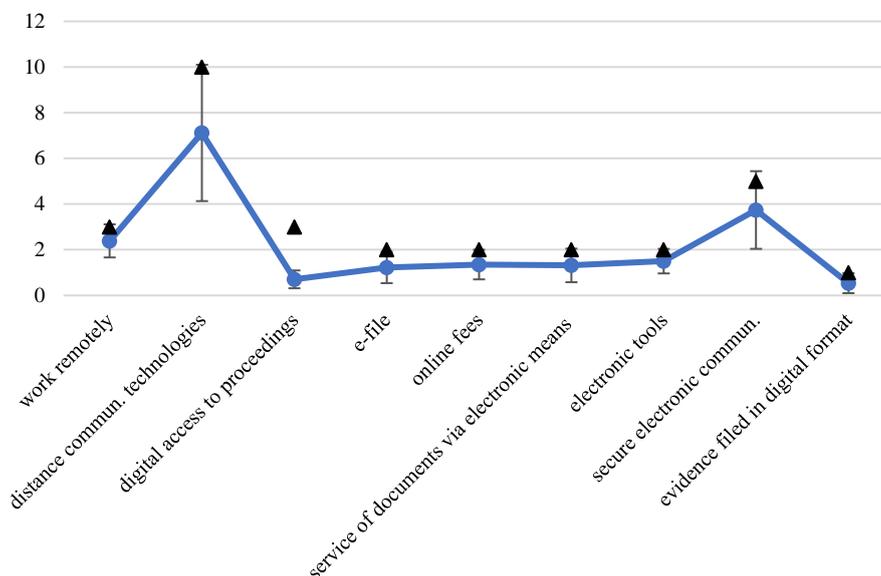


Fig. 21. Digital tools in courts during COVID-19 in EU-27 countries

Data source: [12].

It is too early to say how serious the impact of the COVID-19 pandemic on the efficiency of courts in handling cases will be, but several figures can already provide some initial insights on how the justice systems responded to it, including on how national courts adapted their procedures.

Statistics about the judiciary for 2020 are not yet available from the CEPEJ, so an international comparison is not possible. However, the results from Slovakia show that although the Slovak courts are among the top five EU countries, in terms of digitization, which was needed at the time of COVID-19, the number of hearings was reduced by 20 % in 2020 compared to 2019. The largest decrease occurred in March 2019 by 47 %, in April 2019 by 80 % and in May 2019 by 41 %. The most significant decrease in the number of hearings occurred in the business agenda (by 29%). Also, the data on the filing of new disputes show a decline in filing during lockdowns in 2020 compared to 2019. At the same time, however, it must be said that the number of petitions to the courts has been declining for a long time. Because of this data, it is possible to analyse the highest year-on-year decrease in petitions to the court in commercial disputes, which is by more than 11%. Disputes over consumer contracts fell by 8,6%. The data show that the preconditions for the growth of petitions to the court have not been met. However, they may rise again in the years following the end of the restrictions [1].

In Slovakia, the assumption of experts who expected an increase, the number of litigations in selected areas due to COVID-19, was confirmed. In Slovakia, data for 2020 show a correlation between the rising unemployment rate and proposals for labour disputes in the courts. Due to the increase in deaths, the number of inheritance

proceedings has also naturally increased. Due to restrictions on freedom of movement, homework, deteriorating household income, an increase in the number of marital divorces was expected in Slovakia. However, this expectation for 2020 has not yet been met. Expectations of an increase in family law proceedings due to possible conflict situations that could arise during a pandemic have also not been met [1]

4 Conclusions and policy implications

The comprehensive impact of ICT on individual courts and countries during the first wave of COVID-19 will only be possible if data from the CEPEJ is available, which shows the number of cases, clear rates, and other indicators about the efficiency of the judiciary during the pandemic year 2020. COVID-19's continuing impact on society and businesses, including the judiciary, which will be important to monitor immediately after the lifting of restrictions and the end of several state measures to mitigate the economic effects of the pandemic.

In ICT, national states should focus on the recommendations prepared by the CEPEJ, which have also been evaluated by the European Commission and show significant differences between countries. It is not possible to say which areas countries should focus on first, but an important determinant of the continued use of e-justice should be sufficient cyber protection for users. Judges must also have accessible and modern tools for distance communication.

An important finding is that there does not appear to be a relationship between the overall digitization of public government and the digitization of justice. This conclusion has a significant impact on the direction of expenditures, which are not evenly distributed between the two levels in each country. The overall digitization of public government should go hand in hand with the digitization in other areas of public administration as well as of justice. In addition to investing in e-justice, countries need to invest in the training of judges in ICT, as the two areas are interconnected.

As several studies have shown, it is essential that countries focus their efforts on ensuring a fair judiciary that citizens and businesses can trust. One of the tools for this is digitization, which, among other things, reduces corrupt behaviour. An accessible and fair judiciary during health crises may appear to be a factor influencing the development of future investments.

Answers to the questions of the comprehensive effectiveness of e-justice for the management of civil, administrative, and criminal cases will be of interest in further research.

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Avoiding Middle-Income Trap: Case of China

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Abstract. The middle-income trap is a relatively new concept that became very popular after the financial crisis in 2008. It describes countries that have managed to develop economically from low-income countries to middle-income countries. However, the initial determinants of economic growth have exhausted their potential, and therefore these countries have stagnated economically. China is also currently one of the middle-income countries that a middle-income trap could potentially threaten. We used various absolute and relative methods to determine whether China is in the middle-income trap. However, we did not reach unambiguous conclusions, as the individual methods generated mixed results. The development of other factors such as composition of exports, the enrolment of universities, and the number of patents received over time suggest that China will transform into a modern economy based on services and innovation. However, further reforms are likely to be necessary. Middle-income trap stays as a potential threat for Chinese economy.

Keywords: China, middle-income trap, economic growth,

JEL classification: I 25, O10, O 40

1 Introduction

The World Bank introduced the concept of the middle-income trap in 2006. When researching middle-income countries, World Bank analysts realized that there was no comprehensive theory of economic growth that the World Bank could recommend to middle-income countries whose growth is slowing. The Solow growth model stands on the efficient use of physical and human capital. The World Bank usually recommended the Solow growth model to low-income countries (especially ASEAN countries), focusing on exporting products using cheap labour-power. However, this policy only worked for ASEAN countries until to end of millennium, when Chinese exports began to gain ground, built on even cheaper labour. ASEAN countries, which have since been among the middle-income countries, could not compete with China, and so their

economic growth began to stagnate. Thus, a policy based on cheap labour, especially in the textile industry, was no longer possible.

In the 1990s, alternative endogenous growth theories were developed, which derive economic growth from technological maturity and innovations. As a result, ASEAN countries have started to consider the possibility of changing their public policies in order to promote so-called knowledge economy. However, the World Bank was sceptical. According to them, the then economic development of ASEAN countries was insufficient and therefore did not recommend applying the conclusions of the theories of endogenous growth, which are primarily intended for high-income countries. ASEAN countries have thus fallen into the middle-income trap. Twenty years later, China faces a similar problem as the ASEAN countries. Economic growth based on cheap labour is beginning to reach its limits, which is reflected in a slowdown in economic growth. China will therefore have to prepare a plan to avoid the middle-income trap.

2 Theoretical Background

The concept of a middle-income trap became very popular during the 2008 financial crisis, what we can confirm through Google Trends. Moreover, we can see a similar increase in popularity after the outbreak of the Covid-19 pandemic. [9]

The middle-income trap expresses that past economic success is no guarantee for future economic growth. In essence, the middle-income trap should alert policymakers that constant reforms are needed to sustain economic growth. However, empirical observations show that changing the country's economy based on cheap labour towards a service-based economy and high value-added industries is particularly challenging.

The World Bank defines middle-income countries as those with a gross national income (GNI) per capita at a level ranging from \$ 1,036 to \$ 12,535. Thus, middle-income countries divide into lower-middle-income countries (GNI between \$ 1,036 and \$ 4,046) and upper-middle-income countries (GNI between \$ 4,047 and \$ 12,535). More than 75% of the world's population and 62% of the people we consider poor currently live in middle-income countries. Moreover, middle-income countries produce a third of the world GDP. Their economic and social development will thus be critically important. [13]

The definition of a middle-income trap is not exact. Empirical definitions of the middle-income trap can be divided into absolute and relative. However, the researcher's subjective assessment is also essential. In essence, we can look at the middle-income trap as a trap in which the country falls when public policies have failed to fulfil its potential for economic growth. Therefore, the middle-income trap is primarily the failure of a government that has been unable to prepare the country for transposition into high-income countries.

Felipe [4] brought one of the absolute approaches to the definition of middle-income countries, when researched the shift of middle-income countries to high-income countries. Felipe first divided the countries into four income categories based on GDP per capita (these categories were low income, lower-middle-income, upper-middle-

income, and high-income). Then, based on an empirical analysis of 124 countries, Felipe concluded that a country is in a middle-income trap if it cannot move from lower-middle-income to upper-middle-income in 28 years. The second case of the middle-income trap occurs when an upper-middle-income country cannot advance into the high-income category in 14 years. For a country to become one of the upper-middle-income countries in 28 years, its average economic growth must be at the level of 4.7% per year. The upper-middle-income country needs annual economic growth of 3.5% per year to become a high-income country in 14 years.

Eichengreen [3] looks at how the slowing of economic growth occurs in middle-income countries. Based on empirical observations, Eichengreen states that the slowdown in economic growth usually comes in several waves. Built on the given assumptions, he also sets three rules that must be fulfilled by country to be in a middle-income trap:

- a) The average gross domestic product per capita growth must be at least 3.5% per year over the last ten years.
- (b) The difference between the average growth of GDP per capita over the last ten years and the value of GDP in researched year must be at least two percentage points.
- c) GDP per capita must be higher than \$10,000 in the examined year.

However, Eichengreen also notes factors that can help avoid middle-income traps, such as expanded tertiary education, higher exports of technologically demanding products or quality human capital. Technology and innovation are essential in the process of migrating from middle to high-income countries.

The relative approach to the middle-income trap is based on the developed country (most often the USA), which is set as a benchmark for the examined middle-income countries. In particular, the catching-up process is monitored. A country is in a middle-income trap if it fails to maintain gradual convergence to a benchmark country. [6]

Woo et al. [12] constructed the CUI (Catch-Up Index), which monitors the relative convergence of middle-income countries to the United States, which acts as a benchmark. CUI expresses a ratio between GNI of middle-income countries and the USA. According to Woo, middle-income countries account for 20% to 55% of US GNI. That said, the country is in the middle-income trap if it is within the stated range for more than 50 years after country gained middle-income status.

A very similar approach was chosen by Agénor et al., [1] who took the value of income per capita in the USA as a benchmark. They set the range for middle-income countries between 5% and 45%. Countries are in the middle-income trap if they cannot move from this range for 50 years (1960 - 2010). As we can see, Agénor has chosen fixed date range.

Bulman et al., [2] to some extent, disagree with the concept of a middle-income trap. Instead, they distinguish between the so-called escapees and non-escapees. Escapees are countries that have economically grown since they were among the low-income countries. On the other hand, non-escapees have a problem with economic growth, regardless of whether they belong to low- or middle-income countries. Thus, according to Bulman, if a country failed to exceed the benchmark (stated as 50% of US GDP per capita between 1960 to 2010), we can say that this country is in the middle-income trap.

3 Literature review

China's potential possibility to be in the middle-income trap has been studied quite extensively, especially after 2008. Glawe et al. [6] focus on a more noticeable economic decline in China's GDP growth after 2011. However, the examined indicators show good economic and social development in the country. Nevertheless, political and economic reforms are crucial to make China one of the high-income countries. Glawe and Wagner [7] examined whether the middle-income trap could be avoided based on empirical observations. According to their calculations, China will not fall into the middle-income trap if it can maintain economic growth at 3-4% per year. The transformation of Chinese industry will be needed. Cheap labour will no longer be enough, so the emphasis must be on developing human capital.

Liu et al. [10] stress that technology, innovation and education are drivers for future Chinese economic growth. In the past, Chinese innovations have been implemented in a top-down manner. The Chinese central government controlled the whole process. This approach has enabled China to move from a low-income country to a middle-income country. Nevertheless, this type of policy may not be sufficient in the context of China's move between high-income countries. Greater institutional decentralization with an emphasis on the private sector will be needed. To some extent, this process has already begun.

Zhou [14] examined the problem with a historical approach. The author traces how other countries have economically developed in the past and have moved from low-income countries to middle-income or even high-income countries. South Korea is an example of a country that has avoided the middle-income trap due to its emphasis on innovative industries. On the other hand, Zhou presents Argentina as a country that has specialized in exporting agricultural products and has also fallen into the middle-income trap. In addition, the author deals with different approaches in middle-income countries such as Mexico, Thailand or the Philippines. Finally, Suehiro [11] summarizes the research carried out so far on the middle-income trap issue in Asia's countries. It emphasizes innovation and the school system, which can ensure an easier transition between high-income countries.

4 Methodology

We will empirically test whether China is currently trapped in a middle-income trap based on absolute and relative methods. First, we try the absolute methods from Felipe and Eichengreen. Subsequently, we will focus on the relative methods provided by Woo, Agénor and Bulman. Later, we analyse selected indicators, the development of which will help us predict the economic future of China. We will focus on tertiary education, the quality of education, the composition of exports and the pace of innovation. Eichengreen has defined these indicators as key to avoiding the middle-income trap. Finally, based on the results, we will evaluate whether China is currently in a middle-income trap.

In our research, we will primarily use freely accessible World Bank databases. We will use other internet resources to a lesser extent. We will follow the period from 2000 to the present. This period indicates the time when China moved from low-income countries to middle-income countries. At the same time, it is a period in which China has significantly opened to the world financially and economically.

In the research, we will use standard empirical and explanatory research methods. However, we are aware that some of the opinions presented in this paper may be based on the subjective assumptions of the author. The reason is that the very definition of a middle-income trap is not exact. Therefore, part of the work is relatively polemical.

5 Empirical analysis of China

Based on the World Bank's definition, we can consider China as a middle-income country. According to the Atlas method, Chinese GNI per capita in 2020 is \$ 10,610 (Fig. 1). Thus, we currently place China among the upper-middle-income countries. However, if China maintains its current economic growth rate, it may become a high-income country in the next 3 to 5 years. Thus, China will likely move from a low-income country to a high-income country in about 20 years. From this point of view, we cannot speak of a middle-income trap, as the growth rate of GNI is high throughout the whole reviewed period.

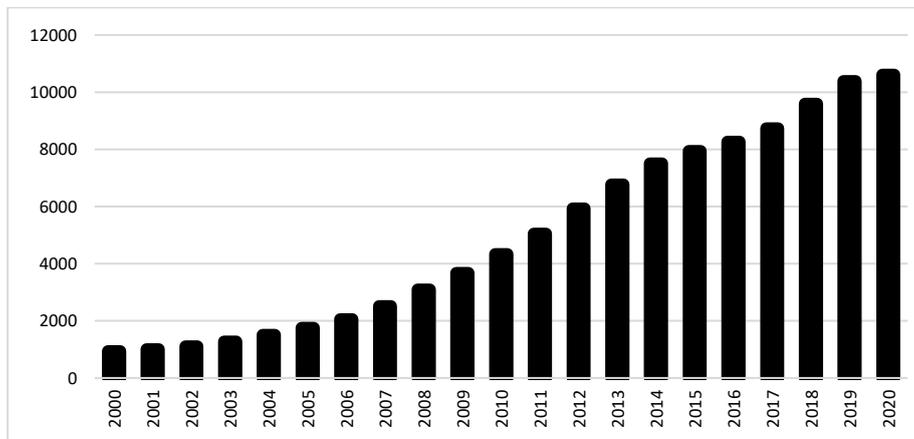


Fig. 22. Gross National Income per capita, Atlas Method (current US\$). Data (World Bank Database, 2021)

GDP growth in China peaked in 2007. Even after the outbreak of the financial crisis, China was able to maintain GDP growth above 6%. However, the growth rate of GDP per capita gradually decreases over time (Fig. 2). Due to the Covid-19 pandemic, we can see a significant decline in economic growth in 2020. According to the Felipe methodology (2012), China is among the high-income countries since 2015. Thus,

China successfully avoided the middle-income trap in which it would have fallen if it had not become a high-income country for 14 years.

Eichengreen set three conditions that define a country in a middle-income trap. Its first condition was met, as China never had economic growth lower than 3.5%. The exception is the year 2020, which was significantly affected by the Covid-19 pandemic. From the overall point of view, we cannot, therefore, consider this year to be relevant. Consequently, we will assess the issue of the middle-income trap from the perspective of the year 2019. Second, China's average growth between 2008 and 2018 was 8.17%. In 2019, China's economic growth was 5.95%. The decline in economic growth in the year under review is thus higher than two percentage points from the 10-year GDP growth average. The third condition (GDP per capita is higher than \$ 10,000 in the observed year) has been fulfilled. Based on this approach, we could therefore assume that China is in the middle-income trap. However, Eichengreen also notes other factors that may affect the economic growth of the countries, which we will discuss in the next section.

Based on two absolute methods (Felipe and Eichengreen), we can conclude that Felipe's approach confirms that China has avoided the middle-income trap. On the other hand, Eichengreen method suggests that China was in a middle-income trap since 2019.

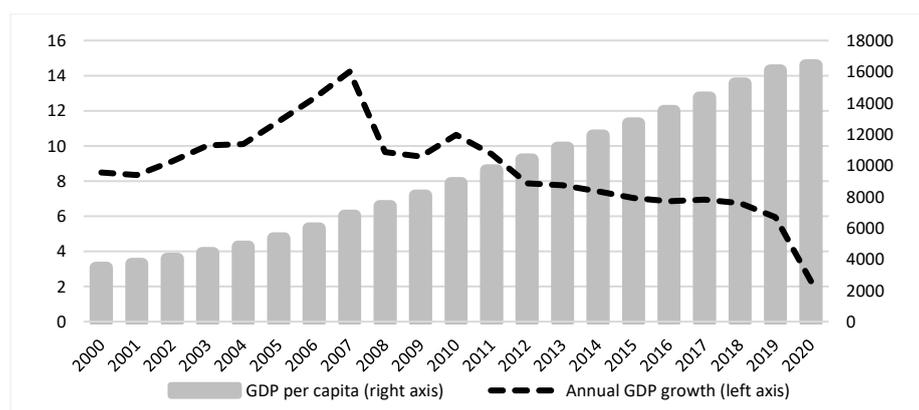


Fig. 2. Annual GDP growth in % and GDP per capita in constant 2010 US\$. Data (World Bank Database, 2021)

In the following section, we analyse the relative approach to the middle-income trap. Based on the Woo approach, we can say that China has not yet become a middle-income country. The limit for low-income countries was set by the author probably too high - up to 20%. Despite dynamic growth in the last decade, according to this method, China has not yet become a middle-income country.

According to the Agénor approach, China became a middle-income country in 2007. However, so far, it has not reached the level of 45%, which the author considers to be the threshold for exiting the middle-income trap. The dynamics of China's convergence with the United States is relatively good. However, the pace of convergence has slowed in recent years. China is approaching the US at a rate of half a percentage point per

year. It would mean that China needs about 60 years to reach the 45% benchmark of the US gross national income.

Bulman came up with a relatively simple condition. The country would be escapee if it reached 50% of GDP per capita in the US by 2010. From this point of view, we can move the benchmark to 2020. We see that China is relatively dynamically approaching the US (Fig. 4), especially after the outbreak of the financial crisis in 2008. In 2020, China's GDP per capita was at 27.24% of the US GDP per capita. The 50% benchmark has not yet been surpassed. China is approaching the USA at a rate of 1-1.5 percentage points per year. By this speed, China would reach 50% of GDP per capita of the US around 2030.

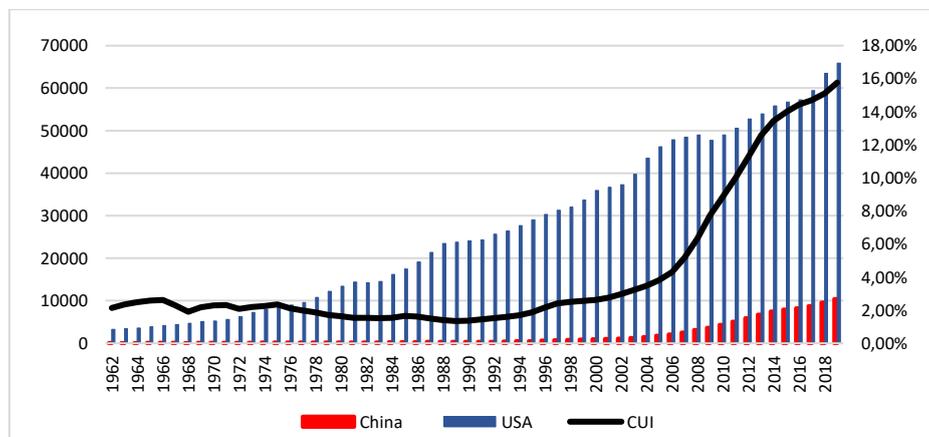


Fig. 3. Gross National Income per capita of China and USA, Atlas Method (current US\$). Data (World Bank Database, 2021). Catch-Up Index (Own processing).

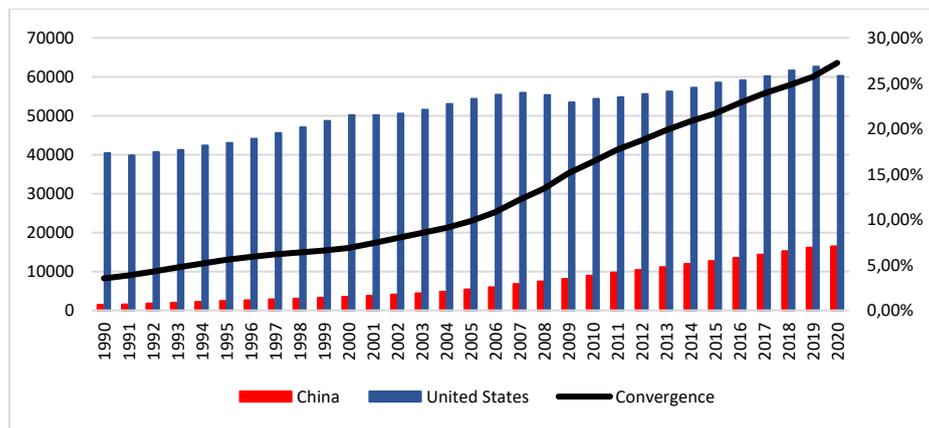


Fig. 4. GDP per capita in constant US\$ for USA and China (left axis) and Convergence of chinese GDP per capita to the GDP per capita of the USA (in %). Data (World Bank Database and own processing, 2021).

The relative approach to the middle-income trap shows that China has not averted the possibility of falling into the trap. Based on the Woo and Agénor methodologies, China has only recently become a middle-income country. On the other hand, the Bulman method predicts that China could avoid a middle-income trap during 2030.

The following section will focus on other indicators that can predict whether China will avoid the middle-income trap. In his work, Eichengreen defines factors such as education, innovation, or the quality of the export mix, which can be very important in overcoming the middle-income trap.

China's export mix remained significantly unchanged for most product groups. However, the categories of clothing, food, and machinery (primarily electronics) are an exception. Therefore, we can see a particular shift to a higher value-added industry in the case of a significant decline in exports of clothing and food. On the other hand, the volume of exports of electronics and tools increased significantly. Thus, with gradual economic growth, we can see the transition to more sophisticated production.

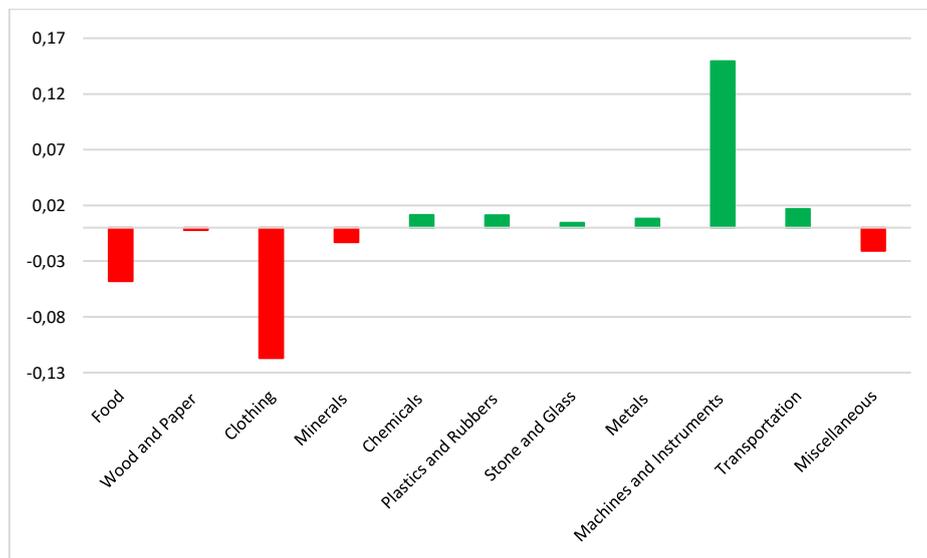


Fig. 5. Change in the composition of Chinese exports between 2000 and 2020 (in percentage points). Data (OEC.WORLD and own processing, 2021).

The country's innovation potential is relatively difficult to measure. Technological sophistication following the level of research can be monitored by the volume of patents accepted. We decided to compare the number of patents accepted per 1 million inhabitants in the two developed countries (USA and Germany) and China. We see that the volume of patents accepted is growing significantly in China. In this context, China is catching up with developed countries, which have been stagnant for a long time. Therefore, we can assume that the Chinese economy will become more and more based on technology and innovation.

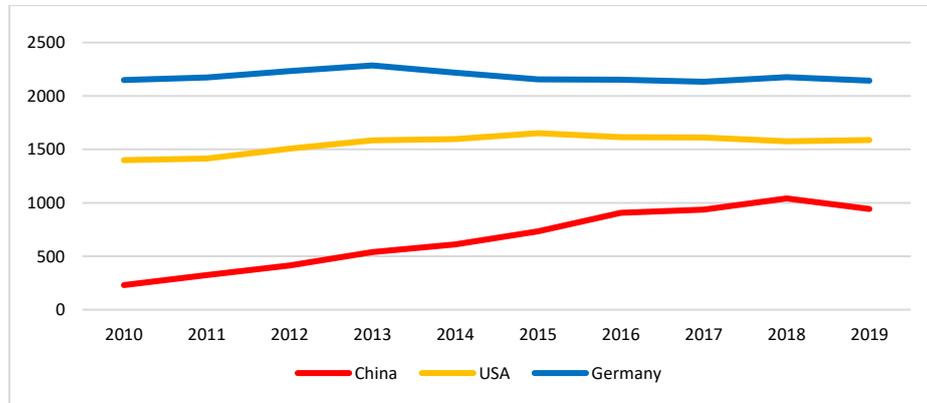


Fig. 6. Number of accepted patents (per 1 million inhabitants) Data (Wipo.int and own processing, 2021)

The basic premise of the knowledge economy is quality education. In the case of China, we can see a fundamental shift in the number of enrolled students in tertiary education. Currently, more than half of all graduates opt for tertiary education. Over the last 20 years, the proportion of students continuing their tertiary degree has increased fivefold. The quality of Chinese universities is also significantly increasing. There are currently 4 Chinese universities in the Top 50 universities in the world. If we add the universities of Hong Kong to the given number, we are talking about a total of 7 universities in the Top 50. At the same time, indeed, Chinese universities are generally moving upwards within the given ranking.

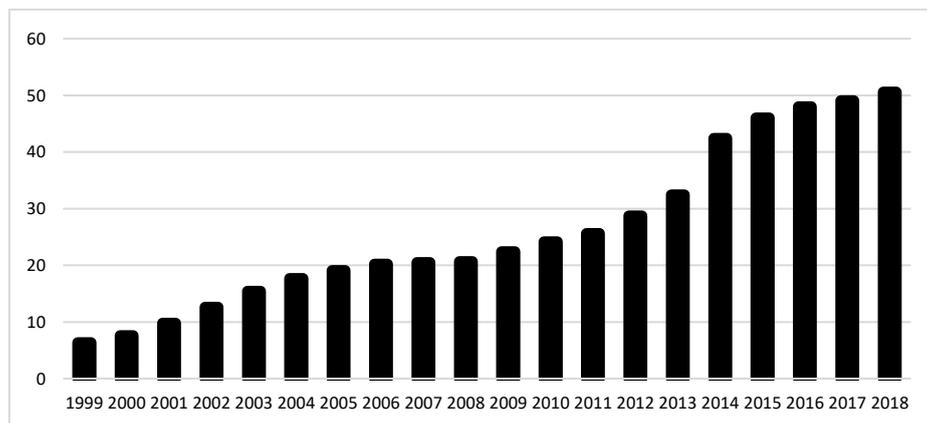


Fig. 6. School enrolment, tertiary (in %), Data (World Bank Database, 2021)

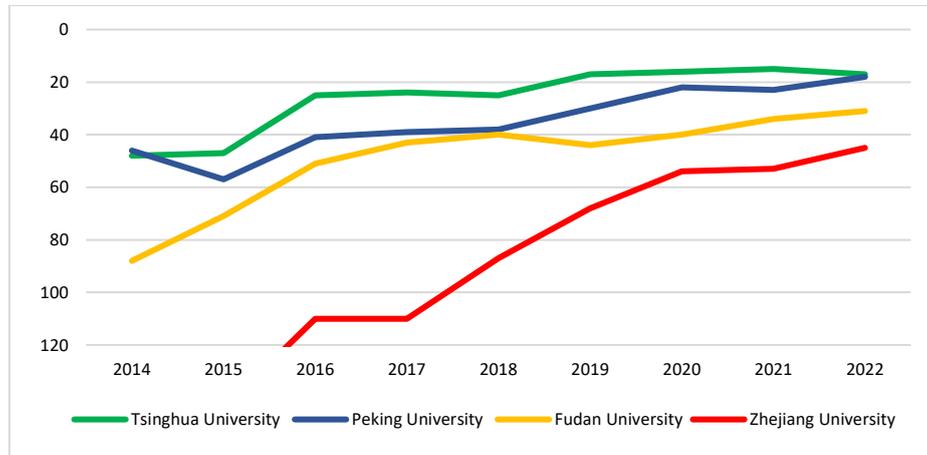


Fig. 7. Top universities in the world. Data (QS World University Ranking, 2021).

6 Conclusions

There is no clear answer as to whether China is currently in a middle-income trap. Absolute and relative methods bring mixed results. However, the current slowdown of Chinese economic growth may indicate that the Chinese economy built on cheap labour has exhausted its potential.

The Eichengreen method has placed China among the countries that are in the middle-income trap. On the other hand, according to Felipe's approach, China is not in a middle-income trap. Relative methods suggest that China has only recently become a middle-income country, and therefore we cannot determine whether it is already in a middle-income trap. Economic and social development in the next 20 years will be crucial.

Indicators regarding education, the composition of exports, and the number of patents accepted suggest that China can gradually transform into an economy based on an educated workforce and innovation. If the trend is confirmed in the incoming years, China will likely avoid the middle-income trap.

China has adopted reforms over the last two decades that have transformed and modernised the country. For example, the Made in China 2025 project concerns modernising China's industry, emphasising technology and innovation-intensive sectors. A similarly ambitious project is the Belt and Road Initiative, which aims to create new maritime and land trade routes between countries in Asia, Africa, and Europe. In this way, China wants to deepen trade between countries and thus ensure that current economic growth is maintained. Based on the monitored indicators, we can say that the Chinese economy is gradually modernising, so China will likely avoid the middle-income trap.

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