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This issue of *Ekonomika preduzeća* starts with a remarkable paper in the *Economic Growth and Development* section written by a trio of experts from the Statistical Office of the Republic of Serbia, *M. Kovačević*, *K. Stančić* and *S. Jelić*. Based on a comprehensive set of data, the authors have analyzed the trends in Serbia's industrial production sector, identifying the subsectors with the highest inclusion in global value chains and their role in overcoming the crisis and fueling growth, but also the ones that lag behind and need to improve their efficiency to be able to seize the opportunities brought by Industry 4.0.

In the *Insurance* section, *V. Vasić*, *J. Kočović* and *M. Koprivica* have sought to determine the most relevant ratios for assessing the financial position and performance of non-life insurance companies in Serbia by applying principal component analysis. The empirical results of their research have shown that it is possible to explain 85% of variability of the initially selected thirty-eight ratios with only six representative ratios, which is a valuable input for further research and decision-making in this area.

In the first paper in the *Finance* section, *M. Grujić*, *B. Mekinjić* and *D. Vujičić Stefanović* have examined the advantages and disadvantages of using the main stock exchange indices and Bitcoin in portfolio optimization. According to these authors, rational institutional investors might take into consideration investing in Bitcoin using the Markowitz portfolio optimization model, but they must be aware of its limitations, bearing in mind that it tends to neglect transaction costs, foreign exchange differences and real value in the stock market. The second paper in this section, written by *I. Janković*, *S. Popović* and *V. Lukić*, provides a critical overview of monetary and fiscal responses to the COVID-19 crisis in the EU and, particularly, in the eurozone. A special focus is placed on Corona bonds, as new join debt instruments, and their potential advantages compared to the European Stability Mechanism.

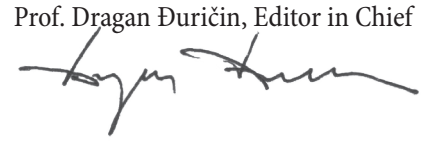
The *Management* section of this issue is dedicated to the concept of quality management (QM) and its impact on business performance of Serbian companies. After carrying out extensive research using a respectable sample of companies, *V. Milovanović*, *S. Janošević* and *M. Paunović* have found that the certification of Serbian companies' QMS to ISO 9001 positively affected their operational and market performance, with the impact intensity dependent upon company size, while its impact on financial performance was examined but not confirmed.

The tourism sector has been among the hardest hit by the COVID-19 pandemic, which is once again evidenced in the paper presented in the *Tourism* section. A team of authors, including *I. Kovačević*, *A. Bradić Martinović* and *G. Petković*, has shed light on the COVID-19 impact on the thematic tourism routes based on the empirical examples of cultural and natural Pan-European thematic routes as well as on the importance of the government's commitment to mitigation measures, including destination promotion support, wage support and utility cost reduction.

In the *Law* section, a duo of authors, *I. Maraš* and *V. Kozar*, has analyzed the existing regulatory framework and practice related to the bankruptcy proceedings and proposed some improvements that could be made to enhance the protection of rights of secured creditors in the bankruptcy debtor asset sales procedure.

Industry 4.0 technological solutions and their implications for logistics have been explored in the last paper of this issue, written by *M. Krstić*, *S. Tadić* and *S. Zečević* and included in the *Logistics* section. The authors have explained the very concept of Logistics 4.0 or "smart logistics", along with the most commonly used technological solutions that form the backbone of its development, such as Internet of Things (IoT), Autonomous Vehicles (AV) and Automatic Guided Vehicles (AGV), Artificial Intelligence (AI), and so on.

Prof. Dragan Đuričin, Editor in Chief



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IMPORTANCE OF THE INDUSTRIAL PRODUCTION SECTOR AND SERBIA'S INCLUSION IN GLOBAL VALUE CHAINS

Značaj sektora industrije i uključenost Srbije u globalne lance vrednosti

Abstract

The share of industrial production in GDP has expressed accelerated decrease for several last decades, while at the same time the sector of services gains an ever-increasing role in the modern society. A general impression is that the process of deindustrialization is an unavoidable global phenomenon. However, the fact that seems to be neglected is that historical observations indicate industrial sector as the pillar of longstanding development and progress, and that its role in overcoming the stages of crisis is of crucial importance, just as showed the episode of COVID-19 pandemic. The modern industrial sector cannot be observed out of the context of international production and trade, which acknowledge and express the final purpose of industrial investments, since they ensure possible overcoming of the national market limits, the achievement of economies of scale in relatively short time, and most importantly – the access to modern technologies. The development of global value chains, i.e. the production fragmentation based on the international division of labour, presents a revolutionary, global phenomenon, which has provided a chance for every country to get included into the process of global industrial production according to its comparative advantages. Serbia takes part in the global value chains owing to its geographic position, respectful human resources/professional staff, infrastructure, and the national openness; however, the implied question is the quality of the participation and what can be done to achieve better results. Can we regard Serbia just as the hub where final products are assembled or there is a considerable value added created in our factories? This paper offers an overview of the subsectors with the highest inclusion in the global value chains, as well as the analysis of their exports, output and gross value added trends, and the parameters of efficiency of investment in the most profitable subsectors. Identifying the areas with low investment efficiency is an important diagnostic tool for decision makers and presents a challenge as regards the adequate allocation of resources leading to increased profitability of investments and exports. Finally, we present the overview of the developments in ICT sector that is recognized as a valuable chance for Serbia, having in mind its increasing share in GDP, and its significance for the forthcoming process of digitalization and Industry 4.0.

Keywords: *industrial production, global value chains, ICT, digitalization, marginal coefficient of investment efficiency.*

Sažetak

Učešće industrijske proizvodnje u BDP-u ubrzano se smanjuje decenijama unazad, dok istovremeno uslužni sektor dobija sve veću ulogu u modernom društvu. Stiče se utisak da je proces deindustrijalizacije sveprisutan globalni fenomen. Ali zanemaruje se i činjenica da je industrijski sektor, istorijski gledano, nosilac dugoročnog razvoja i napretka i da ima ključnu ulogu u prevazilaženju kriznih epizoda, što je pokazala i epizoda sa pandemijom COVID-19. Savremeni industrijski sektor ne može se posmatrati van konteksta međunarodne proizvodnje i trgovine, koje predstavljaju verifikaciju i krajnji smisao ulaganja u industriju, budući da omogućuju prevazilaženje granica nacionalnog tržišta, postizanje ekonomije obima u relativno kratkom roku, i što je najvažnije, pristup modernim tehnologijama. Razvoj globalnih lanaca vrednosti, tj. fragmentacija proizvodnje bazirana na međunarodnoj podeli rada, predstavlja revolucionaran globalni fenomen, koji je svakoj zemlji dao šansu da se u proces globalne industrijske proizvodnje uključi u skladu sa svojim komparativnim prednostima. Srbija participira u globalnim vrednosnim lancima zahvaljujući geografskom položaju, solidnim kadrovima, infrastrukturi i otvorenosti zemlje, ali se postavlja pitanje kakav je kvalitet te participacije i šta se može učiniti po pitanju postizanja boljih rezultata. Da li je Srbija samo čvorište u kome se sklapaju finalni proizvodi ili se u našim fabrikama ugrađuje i

značajna dodata vrednost? U radu je dat pregled oblasti koje su najviše uključene u globalne lance vrednosti, kao i analiza kretanja njihovog izvoza, autputa i bruto dodate vrednosti, a zatim i parametri efikasnosti ulaganja u najprosperitetnije oblasti. Identifikovanje oblasti kod kojih je efikasnost ulaganja niska predstavlja bitnu dijagnostiku za donosioce odluka i izazov u smislu adekvatnog usmeravanja resursa u pravcu veće rentabilnosti investicija i izvoza. Na kraju, prikazan je pregled kretanja IKT sektora koji je prepoznat kao velika šansa Srbije, imajući u vidu njegovo rastuće učešće u BDP-u kao i njegov značaj za nadolazeći proces digitalizacije i Industrije 4.0.

Ključne reči: *industrijska proizvodnja, globalni lanci vrednosti, IKT, digitalizacija, marginalni koeficijent efikasnosti investicija.*

Introduction: Deindustrialization as a trend and fragmentation of global production in the context of development capacities of the national economy

Economic restructuring towards the growth of the service sector and its increasing share in GDP, at the expense of industry, is a global phenomenon in the last few decades present both in the developed and less-developed economies. On the one side, it is a realistic consequence of the productivity growth, which further led to the fall in industrial production prices; therefore, its value added decreased in comparison to the value added of the service sector. In addition, the upgraded living standard induced the growing demands for services, which naturally caused the expansion of this sector. The share of Manufacturing in GDP is decreasing in almost all European countries, and simultaneously the employment in this sector is decreasing. In 2010 Manufacturing in the EU countries had the share in GDP of 15% only (the smallest share was registered in the UK – 11%, and the highest in Germany and Italy – 20% and 18.5%, respectively). The process of extensive deindustrialization has taken place in all post-communist countries even from the nineties of the last century. In Serbia the share of Manufacturing in GDP in the last ten years has decreased by 1.9 p.p. (from 15.2% in 2011 to 13.3% in 2020) [2]. In the Western Balkans countries, similar trends were noted in Croatia (from 13.7% in 2011 to 12.2% in 2020) and Romania (from 24.9% in 2011 to 15.4% in 2020). In Bulgaria the share of Manufacturing equals about 13% in the last decade, a moderate growth was recorded in North Macedonia (from 11.4% in 2011 to 12.5% y 2020), while Albania and Montenegro in 2020 recorded the lowest participation of Manufacturing in GDP of 6.2% and 3.7%, respectively.

However, historical observations indicate that the source of economic growth and upgraded living standard has always been a strong industrial sector, since there around capital stock, innovations, productivity and exports are concentrated. The phenomenon of favourable impact of strong industrial sector both in the process of recovery after recession and in further economic development is undoubtful [7]. Real economy is of crucial importance for managing crisis, and the experience of the countries with developed industry (e.g. Germany), showed that they not only overcame crisis more quickly, but their comeback to the pre-crisis development level was sooner. After the global economic crisis of 2008, the interest for industrial revitalization revived, and the European Commission passed the Strategy of reindustrialization (European Industrial Renaissance), which defined as objective the increased participation of Manufacturing in GDP until 2020 from 15% to 20%. General government would have an important role in the process of economic revival, and its supporting measures would help supress negative market formations that obstruct sound industrial dynamics and development.

The Serbian solid economic results for 2020 – the GDP fall of only -1%, public debt equalling 57.4% GDP and deficit equalling 8.1% GDP – mostly originate from the economic structure with dominant industry, agriculture and construction. Therefore, we may conclude that the resistance of the Serbian economy is grounded on the independence from the sector of services, which was mostly stricken by the pandemic. Generally, as the most important flywheel and transmission vector of industrial production regarded are international trade and fragmentation of production based on international division of labour, namely – global value chains. Participation in global value chains offers unlimited possibilities for the national industry expansion. However, international production has become rather complex, fragmented and globalized, with clear market rules and principles that for interrelated actors offer numerous and unlimited chances as regards the access to markets, but also make them strongly interdependent and sensitive to shocks.

An inevitable issue is to determine how the relative position of the national economy and the extent of its participation in global value chains influence the prosperity of companies and of the entire production sector of an economy. Are their capacities for innovations sufficiently advanced and is the division of labour, being the result of fragmented production, of productive character? What agent in the production chain has the most benefits from foreign direct investments, which are directly related to the inclusion in global value chains and multinational production network? The inclusion in global value chains is by all means the key determinant of economic growth but also a required step towards industrialization, and towards targeting certain industries where an economy can be well established for a long term, in accordance with the capacities and possibilities. Inclusion in global value chains assumes also easily achieved status of economies of scale, where local and regional markets are small, and the access to faraway markets is ensured through fragmented production. This is particularly important for developing economies, since thereby provided is the option to gain knowledge through the production process and "learn how to learn".

Nevertheless, just as any economic decision, so the decision on the country inclusion in global value chains has to be based on the estimation of attractive activities, historical backgrounds, geographic position, and national specific features. Absorption capacities of a country are also rather significant, namely, the labour force knowledge and know-how, and the local infrastructure development level. Finally, as perhaps the major component of the entire process of inclusion in global value chains we need to consider the evaluation of the performance of the sector and companies involved.

Is this the end of the era of global value chains expansion?

The production organization according to the stage of specialization, i.e. production process reallocation to the countries with the lowest labour costs and production expenditures, has achieved its maximum in the period from 1990 to 2008, which is frequently referred to as the era of hyper-globalization. In other words, then the system of global value chains of production and supply was established and developed. This production process organization followed the integration of the East European countries into the world market (after the Fall of Berlin Wall), simultaneously with the expansion of China and its joining the World Trade Organization in 2001. The development of global value chains came simultaneously with the progress of information technologies, transport services, liberalized trade and globalization, when every country had the option to take part in the production and trade chain in the stage where it finds the best comparative benefits. Thereby upgraded was productivity on all production levels, competition was improved, transfer of knowledge and technologies was ensured, and eventually – achieved was better market supplying and upgraded quality and variety of offers. Higher integration into global value chains stimulates companies to invest into innovation and so generate new ideas and solutions, and in this way gradually become the centre of technological transfer in their surroundings. Hyper-globalization had tremendous effects in social and demographic domain; however, these topics cannot be covered by this study. It is worthwhile noting that poverty reduction was facilitated and that globally the number of the most poverty-stricken people (with consumption below two US dollars daily) has decreased by more than one billion since the end of the last century eighties.

It is estimated that in the period from 2000 to 2008 global value chains made as much as 60% of the world trade. Their expansion was stopped by the economic crisis in 2008, due to the enormous indebtedness of the European Union and escalated insecurity in the global economy, which slowed down the production and trade flows. In this constellation producers estimated the risk of placing products into the market as unprofitable; therefore, the production reduction followed, and risky and faraway destinations became avoided. Similarly, it is estimated that the coronavirus pandemic has caused an increased and lasting insecurity that, along with other factors, will inevitably induce the reduction of global value chains. Namely, due to increased costs and insecurity as regards sales, production displacements into non-resident, faraway

countries have become costly and unsustainable. Besides, in near future expected is increased protectionism and customs duties jump, which frequently follow crisis, and this will make the organization of production into several countries even more complicated and expensive.

Public speculations have already suggested that many developed countries consider and start the process of taking production back to the resident country, with increased adjustments of machinery and robotics that have proved to be less expensive and more efficient than human labour force even before the pandemic, and especially during the pandemic. Robotics and automation, with the costs of their introduction having falling trend ever since the last century nineties, in the future will become even less expensive due to the expected fall or stagnation (on the low level) of interest rates. Coronavirus pandemic has already accelerated these processes and numerous companies were forced to make considerable investments in digital transformation. It is hard to imagine this trend to be stopped, on the contrary – it is expected to become even more dynamic, and simultaneously the production would be taken back to the resident countries, which is expected to cause the strong contraction of global value chains. As some estimations suggest [4], for several years certain subsectors of Manufacturing have been taken back to the resident countries. The leader here is chemical processing industry, which is ranked as "number one returnee" in Germany, Italy, France and USA. Similar trends can be expected for car/automotive industry, the group that is best integrated in global value chains with robotics most represented in the production, so that their further application will be easily resumed.

Western Balkans and global value chains

The Western Balkans countries (hereinafter: WB)[1] in global value chains participate as importers of products from other countries; however, the value added built in the products they export is [3] small and insufficient. In the global production organization process the WB countries mainly function as "assembling centres" where final products are assembled. Also, instead of being directed towards Germany, which is the EU foreign trade intersection, the WB countries primarily create regional exchange connections, and a few of them are oriented towards Italy (that itself passed through a recession episode and its economy in the last years has been rather volatile, this inevitably being reflected on its foreign trade partners). Based on the results of the IMF survey[2], implemented on a sample of 66 top importing companies from five WB countries (Albania, B&H, North Macedonia, Montenegro and Serbia), it was determined that most of these companies (46%) function on so-called bottom line in supply chain, i.e. in the production process of *labour intensive* goods with low value added. Therefore, in global value chains these companies are connected with many EU and OECD countries, however they mostly function as importers, i.e. act as final products assemblers. 37% of companies deal with exports of services, and only 18% with the production of high value goods. Regarding the staff qualifications, medium level education is prevailing (51%); as the top issue and limiting factor to increasing exports the companies covered by the survey stated the lack of human resources that could absorb new knowledge and technologies. Following the lack of adequate staff, the factor that has inhibitory effect on the development of global value chains in the WB countries is low level quality and development of legislation and (authorized) institutions. Namely, the lack of respective institutions prevents smooth functioning of investment and commercial arrangements and does not ensure adequate legal assistance and protection for investors. Even the investors present in the WB region as the major obstacles for larger production expansion state the lack of the staff knowledge and skills, apart from political instability, undeveloped traffic infrastructure and institutional problems. Their motivation for the investment in the region is reduced to attraction due to cheap labour, location and tax reliefs granted by the government.

For successful integration in global value chains, it is not enough to have low-paid labour force that will make

1 IMF here includes Albania, B&H, Kosovo, Montenegro, North Macedonia and Serbia.

2 The purpose of the survey was to identify the major obstacles that these companies encounter in the process of inclusion in global value chains, as well as other influencing factors – such as company characteristics, number and quality of the employed staff, etc.

the basis for competition. On the contrary, *productivity and efficiency* need to be upgraded, and that assumes actions on improving quality of institutions, human and physical capital and infrastructure. By way of foreign investments national economy should get included in global value chains; therefore, it is required to ensure a highly professional and efficient institutions, the rule of law, harmonized legislation, and all other arrangements needed for cross-border trade. In addition, to improve competitiveness it is of utmost importance to invest in the education quality, and staff knowledge and skills. Frequently, a country may get stuck in stagnant pitfalls of combining low staff earnings and low productivity and so gradually lose its comparative advantages and get expelled by the present competition. For this reason, the WB countries are permanently induced to implement structural reforms, the importance of which is even more considerable than the standard factors that at first sight mainly influence trade relationships (close location of certain market, common border, linguistic advantages, cultural heritage, etc.). Besides, it is necessary to better explore the possibilities of already existing arrangements, to the effect to include legally binding provisions that would ensure facilitated solving of disputes, property legal protection, and stipulate all other delicate domains of investment processes.

Since the countries of the region are in the process of accession to the EU, by adopting the accession measures they would considerably add to strengthening national institutions and competition. The integration of Serbia, and of the region as well, in global value chains is mostly determined by their EU integration, which is implemented through the Stabilisation and Association Agreement, while the detailed commercial issues are stipulated by the Transitory trade agreement establishing the free trade zone between Serbia and the EU. Serbia is thereby obligated to gradually revoke customs duties on imports of goods originating from the EU, while on the other side by this agreement the EU has acknowledged free access of the goods from Serbia to the EU market [6]. The significance of this agreement is undisputable, since it not only ensured more notable presence of our country in the EU market, but also larger FDI inflow and thereby better integration in global value chains. Further integration will depend upon the infrastructure development, Serbia's progress towards the EU and political stability.

Serbia's integration in global value chains

To clearly understand what production activities fall in the category of global value chains, the best way is to consider them in the context of cross-border interaction. To this effect, four types of production are distinguished [8]: first, where value added is produced within the borders of a national economy and is absorbed by the domestic market; second, where a complete product is manufactured in one country and is exported as a final product to another country (this is a traditional trade type); third, where a product is manufactured in one country and is exported as semi-product to another country, which will incorporate its value added during the process of its finalization; and fourth, where value added is incorporated in a product several times in each of the countries that imports it as semi-product and then exports it further, all the way to its complete finalization. Therefore, the third and the fourth type of activity fall within production activities covered by global value chains.

The inclusion in global value chains can be presented as the sum of amounts of imported inputs that take part in the production dedicated to exports, with the added amount of exporting intermediate products incorporated in the exports of other countries. In global value chains imports have equally significant role as exports, because of the fact that by purchasing technologically advanced inputs (capital-intensive products) for domestic companies ensured are increased productivity and access to new technologies. The processing of these products is sophisticated as well and entails high value added, thereby stimulating intense integration of domestic companies in global value chains. Therefore, imports that insure to companies (functioning on a higher level of technological further processing, i.e. creating more value added) to incorporate technologically advanced inputs into their products can also be regarded as a stimulus to exports of the same companies since their production quality and competitiveness are upgraded. The positive role of imports is undoubtful in this case, in contrast

to labour-intensive companies and sectors that carry out product assembling, and where imports are unproductive and in value far higher than exports. However, to make use of the benefits of imports, a complex business paradigm needs to be designed, assuming adequate capacities, but in the first place adequately educated labour force able to absorb and apply new knowledge and technologies. In this case imports act as multiplicator of exports and may be regarded as ensuring economic growth model grounded on exports.

In March 2021, the Vienna Institute for International Economic Studies released the results of the survey on the WB countries' integration in global value chains [5], based on input-output tables, where it is possible to see in detail the share of the foreign value added incorporated in the total exports of goods and services of a country (backward linkages), as well as the share of the domestic value added incorporated in domestic exports and the foreign county's exports (forward linkages). With its better integration, a country will have more value added integrated in its exports; namely, foreign countries will use its value added in their production process (and in their exports).

Expectedly, all six countries covered by the study (Serbia, Albania, North Macedonia, Montenegro, B&H, Kosovo*) show a larger share of incorporated foreign value added in their exports than is the share of their value added in foreign exports. *Forward linkages* are in all countries on the level of about 10% of the total exports, while *backward linkages* are different and vary from 12.2% in Albania to 33% in North Macedonia (data for 2018). To avoid simplified interpretation of these results it should be noted that the more an industry is developed – the more it uses inputs where foreign value added is incorporated.

According to the survey results, in Serbia we registered the largest share of foreign value added in the total exports in six divisions of Manufacturing:

- Manufacture of motor vehicles, trailers and semi-trailers,
- Manufacture of electrical equipment,
- Manufacture of rubber and plastic products,
- Manufacture of basic metals,
- Manufacture of machinery and equipment n.e.c,
- Manufacture of chemicals and chemical products.

This came as expected since these Manufacturing divisions express the highest dynamics and expansion in the last few years and use considerable amounts of foreign inputs in their production process. Simultaneously, these are the divisions where the highest share of domestic value added in exports was recorded, indicating that productive sectors are in question where imports are used in a productive manner for the purpose of exports growth and not only regional centres carrying out final processing and product assembling.

These six mentioned divisions that are best integrated in global value chains, in 2020 recorded the top value of exports of goods expressed in euros[3]:

- Manufacture of motor vehicles, trailers and semi-trailers – EUR 1.74 billion,
- Manufacture of electrical equipment – EUR 1.69 billion,
- Manufacture of rubber and plastic products – EUR 1.50 billion,
- Manufacture of basic metals – EUR 1.24 billion,
- Manufacture of machinery and equipment n.e.c – EUR 1.07 billion,
- Manufacture of chemicals and chemical products – EUR 1.01 billion.

In 2020 these six divisions participated in the total exports of goods with 48.4% (43.2% in 2010) and in the exports of manufacturing with 53.9% (49.9%). At the same time, these are the only divisions (apart from Manufacture of food products) with the individual exports in 2019 and 2020 found on the level of about EUR 1 billion.

In 2019 related to 2010[4], all six divisions achieved considerable export growth: Manufacture of motor vehicles, trailers and semi-trailers – 761%, Manufacture of electrical equipment – 242%, Manufacture of rubber and plastic products – 248%, Manufacture of machinery and

3 Precisely, the largest exports value was noted for Manufacture of food products (EUR 1.79 billion), but it is not important for the present study since this is a division without a considerable share of incorporated foreign value added in its exports or a considerable share of domestic value added in foreign exports; namely, it is not integrated in global value chains.

4 The comparison 2019 to 2010 was carried out for the sake of compatibility with the comparison of data on the trends of GVA and output, where the last available data come from 2019.

equipment n.e.c – 275%, and Manufacture of chemicals and chemical products – 97%. However, for a major part of them exports growth was more expressive than the growth of total exports and the exports growth of Manufacturing that in the ten-year period equalled 132% and 138%, respectively.

However, even though the exports of the mentioned six divisions have expressed strong growth and they may be regarded as the moving force of the Serbian exports industry, the linear increase of output and value added has not followed (see Table 1 and Figures 1-3).

Anyhow, in the last ten years for all six divisions GVA growth has been recorded: the largest for Manufacture of motor vehicles, trailers and semi-trailers (162% in 2019 when compared to 2010) and Manufacture of rubber and plastic products (62%). Apart from Manufacture of basic metals, each of these division increased its share in the GVA of Manufacturing: in the first place Manufacture of motor vehicles, trailers and semi-trailers (by 2.3 p.p.) and Manufacture of rubber and plastic products (by 2.1 p.p.).

However, after gaining the top value for certain divisions value added started to decrease (Manufacture of motor vehicles, trailers and semi-trailers) or stagnate (Manufacture of electrical equipment). Regarding *Manufacture of motor vehicles, trailers and semi-trailers*, from 2013 value added and output have been continually decreasing. In the same period, after achieving the top value in 2013, exports firstly recoded moderate fall and then new growth, which all the way until 2019 remained average values (about EUR 1.9 billion annually). A similar trend was notable for *Manufacture of electrical equipment*: namely, exports of this division have recorded average annual growth of about 14% in the ten-year period, while at the same time output has recorded moderate growth, and GVA has stagnated. These movements, i.e. discrepancy among output/GVA and imports, can be regarded as increased input costs, i.e. increased value of imports component that exceeds the growth of produced value added, or as increased exports from the stocks. Namely, even though these are the most productive exports sectors, where imports are productively used for the purpose of exports growth, incorporated value added still notes moderate measures, and worryingly – has falling trend.

However, for some divisions the growth of exports is accompanied by an adequate growth of value added, and vice versa. For example, *Manufacture of rubber and plastic products* has registered faster growing GVA compared to output, and in the ten-year period exports have increased by 248%. Similar trends have been seen regarding *Manufacture of chemicals and chemical products* and *Manufacture of machinery and equipment n.e.c.*

Regarding other Manufacturing divisions, the case of *Manufacture of food products* should be noted (see Figure 4). Namely, individually considered this division has been creating the largest share in GVA of Manufacturing for several last years (about 19% on average, in the observed ten-tear period). Also, its participation in Industrial production is ranked at the second place (15.6% in 2019, directly following the section Electricity, gas, steam and air conditioning supply with the share of 16.7%). Therefore, the exports of Manufacture of food products division holds the high second place in the Serbian exports: 10.5% in 2019, immediately after the exports of Manufacture of motor vehicles, trailers and semi-trailers division that recorded the share of 12.4%. This is traditionally highly represented industrial division in the Serbian economy. However, in

Table 1: Real trends of output, GVA expressed in RSD (value chain-linked volume measures) and exports; growth rates, 2019/2010, %

Divisions of the Manufacturing section	Output	GVA	Exports	Share in GVA of Manufacturing, change 2019/2010, p.p.
Manufacture of rubber and plastic products	56.6	61.8	247.7	+2.1
Manufacture of chemicals and chemical products	14.3	15.3	96.7	+0.8
Manufacture of motor vehicles, trailers and semi-trailers	127.2	162.0	761.5	+2.3
Manufacture of machinery and equipment n.e.c	27.5	26.9	247.9	+0.4
Manufacture of electrical equipment	35.4	21.7	242.1	+0.2
Manufacture of basic metals	-2.0	8.7	33.6	-0.3

Figure 1: GVA movements, 2010-2019, value chain-linked volume measures, reference year 2015, RSD million

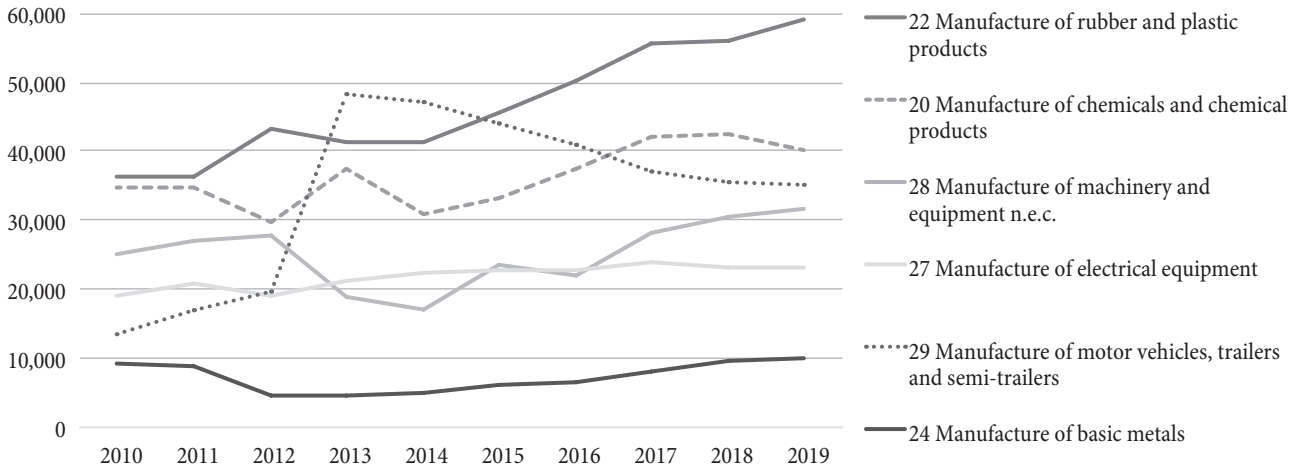


Figure 2: Output movements, 2010-2019, value chain-linked volume measures, reference year 2015, RSD million

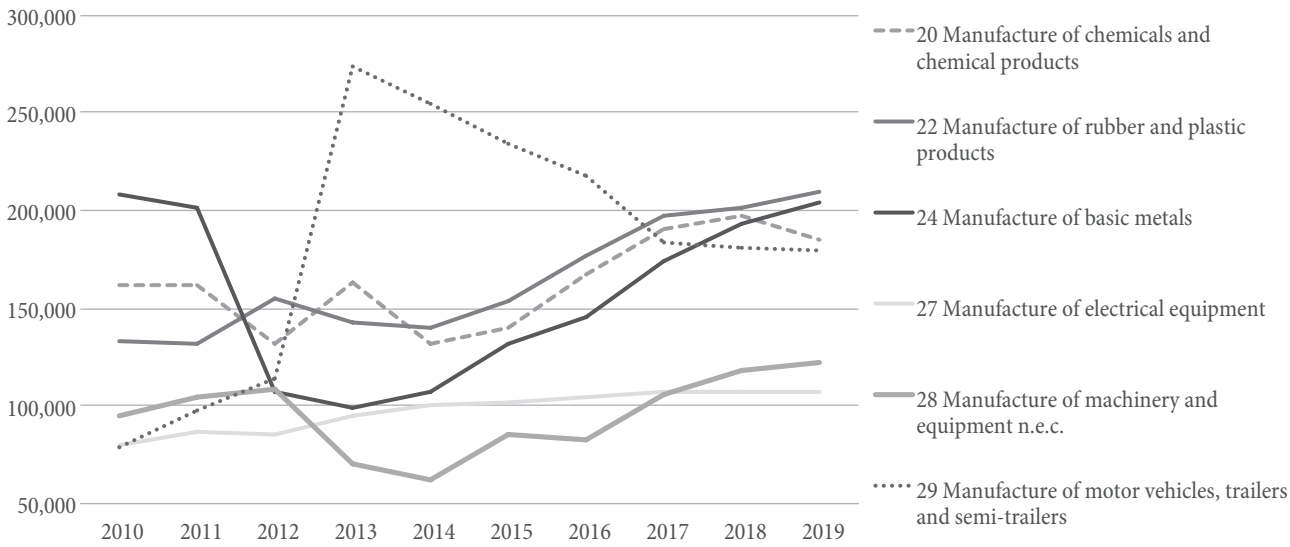
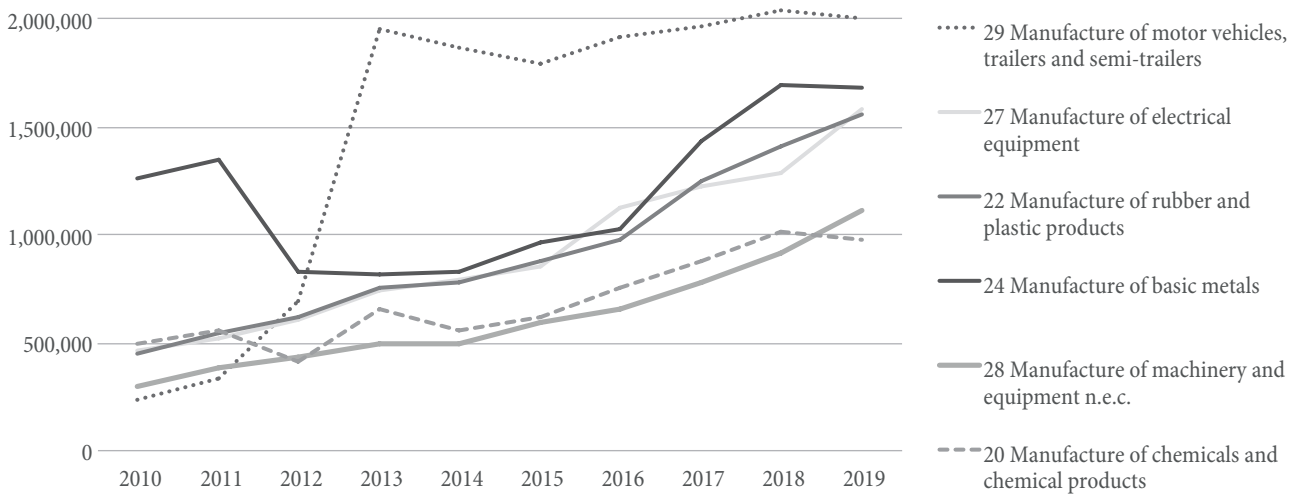


Figure 3: Exports movements, value in EUR thousand, 2010-2019



2019 the GVA of this division was by 1.7% lower than in 2010. In the same period, the output decreased by 5.9%, and production physical volume by 4.4%. So, observed from the point of production and value added, Manufacture of food products expresses extremely negative trends, while simultaneously its exports still record growth. An explanation here is that the Serbian Manufacture of food products is found blocked between uncovered domestic demands (that are covered from imports) and growing demands from the surrounding countries. This is the reason why in time it has become reoriented from the domestic to the foreign market, while simultaneously its structural propulsion has continually decreased, which the negative GVA trends confirm. Obviously, the most represented is the manufacture of products recording low value added, while the measures higher processing level are rather moderate. In addition, even though in the last ten years the consumers' preferences have changed in favour of foreign products, domestic products are neither by price nor quality competitive to foreign products. Unfavourable dynamics of the movements of this industrial division is by all means a disputable issue; however, the worrying trends of the GVA fall indicate possible lagging behind in applying modern technologies in production processes.

The results of the linear regression model with trend, applied with the aim of examining the relationship between the GVA and exports movements in the seven mentioned divisions, mainly confirmed the expectations (Table 2). Namely, as regards the exports and GVA of Manufacture of food products no significant statistical relation exists, just neither for Manufacture of electrical equipment. For both divisions there exists high statistical significance between the trend movements and exports, i.e. the entire variability of exports movements can be explained by trend function, and not by GVA variation. Therefore, GVA does not grow with exports growth, which is understandable,

Figure 4: Manufacture of food products, trends of exports, output and GVA, 2006-2019; left side scale – exports, value in EUR thousand; right side scale – output and GVA, value chain-linked volume measures, reference year 2015, RSD million

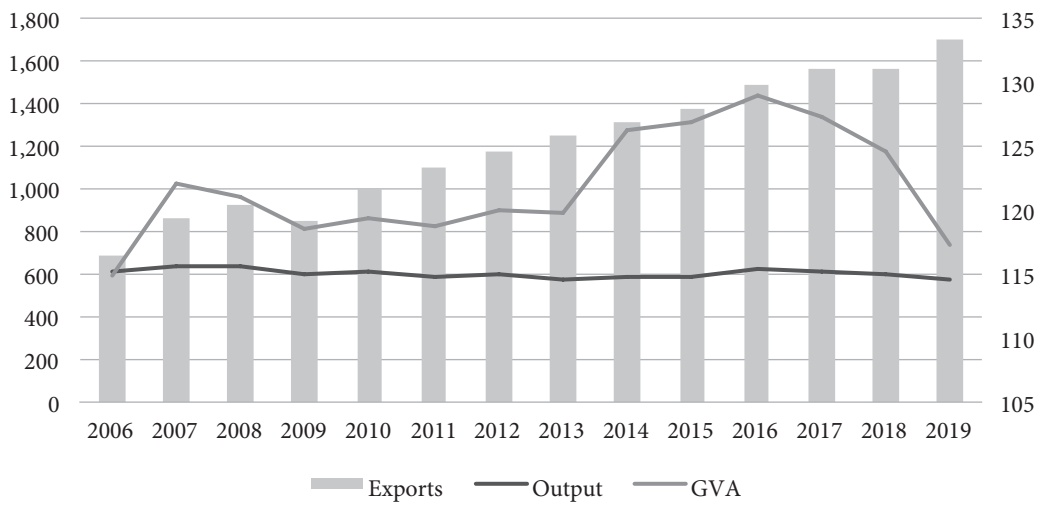


Table 2: Results of linear regression model with trend

Exports - divisions of the Manufacturing section	The regression coefficient GVA to exports	R^2 (coefficient of determination)
10 Food products	2.27	0.94
20 Chemicals and chemical products	13.39 ***	0.93
22 Rubber and plastic products	13.89 ***	0.96
24 Basic metals	193.84 ***	0.93
27 Electrical equipment	-3.79	0.94
28 Machinery and equipment n.e.c	8.10 ***	0.94
29 Motor vehicles, trailers and semi-trailers	37.55 ***	0.94

Notes: *** Marked is statistical significance on the level of 1%.

because of the general feature of these industries with low processing level. For other five divisions, the model confirmed high interdependence between the GVA and exports movements.

Economic efficiency parameters of the Serbian Manufacturing section

Considering the fact that the gained GDP level represents the key determinant of the overall economic progress and the most adequate measure of the social wellbeing, finding the optimal way to achieve long-term rising GDP movement creates the grounds for all macroeconomic analyses and objectives. To this effect, investments are expressive as the key lever of the economic progress dynamics, in all their quantitative and qualitative manifestations. Only the quantitative, i.e. physical volume of investments cannot be seen as the measure of progress; however, this is the *contribution to production* that results from the increased production capacities. Therefore, for the purpose of planning and taking economic decisions it is desirable to examine the level of profitability of capital investments and in this way to recognize new potentials for growth and progress.

The transmission of investments in an economy is carried out through investment in machinery, equipment, software, etc. on the one side, which can increase production capacities of certain sectors; and investment in infrastructure, building constructions, etc. on other side, which upgrades social wealth and simultaneously is a prerequisite for the efficiency of all other investments observed on long-term basis. Therefore, by strategic direction of resources and reallocation of capital through investments it is possible to influence economic restructuring in order to achieve economic optimization. However, to create a sound starting point for making decision on effective investment, in the first place it is needed to review the variants in investment efficiency by certain industrial divisions.

As the main indicators defining and measuring the success of investments by various economic activities used were conventional macroeconomic indicators, such as capital coefficient and economic efficiency of investments, both in their average and boundary form, while marginal capital coefficient presents the relation of investments and GDP increase, and marginal coefficient of investment efficiency is reciprocal expression of marginal capital coefficient.

With the aim of understanding more clearly the movements of economic efficiency of investment in Serbia in the last decade, in Table 3 we offered a comparative overview of the mentioned indicators by the divisions of the Manufacturing section for the years immediately after the great economic crisis (2010-2014), as well as for the five-year period where recorded were the first results of the implemented fiscal consolidation aimed at achieving macroeconomic stability and initiating a new investment cycle[5] (2015-2019).

When as an indicator of the capital investment efficiency observed is the movement of marginal coefficient of investment efficiency in the last decade in Serbia, we can conclude that the section of Manufacturing shows rising investment efficiency (0.11) in the period 2015-2019 when related to the period immediately after the great economic crisis (0.04). Further on, regarding the share of divisions in the GVA of Manufacturing, the following facts are notable:

- Manufacture of food products, expressing the largest share in the GVA of Manufacturing (18.8% on average in the observed ten-year period), at the same time is found at the bottom of the rank list by investment efficiency (-0.07). Moreover, marginal coefficient of investment efficiency decreased in the period 2015-2019 when related to the period 2010-2014, from 0.07 to -0.07; thereby Manufacture of food products moved down by 10 standings on the rank list of investment efficiency of Manufacturing divisions – from the position 10 to the position 20. Even though Manufacture of food products because of its relative importance strongly influences the entire Manufacturing section, its efficiency on the whole even increased owing to the upgraded business profitability in the 15 divisions.
- The divisions: Manufacture of tobacco products, Manufacture of basic metals, Manufacture of

5 In the period 2015-2019, fixed investments grew at the average annual rate of about 10%, while their cumulative growth equalled about 64%. The share of fixed investments in GDP increased from 15.9% in 2014 to 22.5% in 2019, i.e. by almost 7 p.p.

Table 3: Comparative overview of Manufacturing business efficiency parameters by economic structure in two observed periods

Divisions of the Manufacturing section	2010-2014				2015-2019			
	Rank by investment efficiency within Section C	Marginal coefficient of investment efficiency*	Share in GVA of Manufacturing, %	Average GVA real growth rate, %	Rank by investment efficiency within Section C	Marginal coefficient of investment efficiency	Share in GVA of Manufacturing, %	Average GVA real growth rate, %
C - Manufacturing	-	***0.04***	-	***0.8***	-	***0.11***	-	***2.4***
10 Manufacture of food products	**10**	0.07	18.9	1.3	**20**	-0.07	18.7	-1.5
11 Manufacture of beverages	**12**	-0.03	4.5	-0.5	**18**	0.02	4.3	0.4
12 Manufacture of tobacco products	**13**	-0.05	0.7	-1.0	**4**	0.42	1.3	9.8
13 Manufacture of textiles	**20**	-0.56	1.9	-3.5	**5**	0.41	1.9	5.0
14 Manufacture of wearing apparel	**4**	0.20	3.9	1.8	**15**	0.07	4.0	0.8
15 Manufacture of leather and related products	**21**	-0.91	1.9	-4.1	**21**	-0.11	1.4	-2.3
16 Manufacture of wood and products of wood, except furniture	**6**	0.18	2.1	4.3	**24**	-0.40	2.3	-3.5
17 Manufacture of paper and paper products	**1**	0.29	2.8	5.5	**7**	0.27	3.1	6.1
18 Printing and reproduction of recorded media	**11**	0.06	2.2	0.4	**19**	-0.04	1.6	-0.8
19 Manufacture of coke and refined petroleum products	**9**	0.10	7.8	5.7	**16**	0.03	7.4	1.1
20 Manufacture of chemicals and chemical products	**8**	0.11	4.6	2.6	**12**	0.19	5.7	5.2
21 Manufacture of basic pharmaceutical products	**2**	0.28	2.4	4.9	**9**	0.25	2.4	5.2
22 Manufacture of rubber and plastic products	**7**	0.11	6.4	2.8	**8**	0.26	8.1	7.4
23 Manufacture of other non-metallic mineral products	**14**	-0.08	4.1	-1.5	**10**	0.19	4.2	3.9
24 Manufacture of basic metals	**15**	-0.10	1.0	-7.3	**11**	0.19	1.1	15.3
25 Manufacture of fabricated metal products, except machinery	**17**	-0.23	13.6	-2.1	**6**	0.32	11.3	5.9
26 Manufacture of computers, electronic and optical products	**23**	-1.30	2.9	-10.5	**23**	-0.24	2.1	-2.8
27 Manufacture of electrical equipment	**3**	0.26	3.1	5.8	**17**	0.02	3.4	0.6
28 Manufacture of machinery and equipment n.e.c.	**19**	-0.52	3.6	-9.1	**2**	0.81	4.0	13.2
29 Manufacture of motor vehicles, trailers and semi-trailers	**5**	0.20	4.8	27.7	**22**	-0.16	5.7	-5.8
30 Manufacture of other transport equipment	**24**	-3.36	1.0	-24.3	**3**	0.48	0.5	7.1
31 Manufacture of furniture	**22**	-1.20	2.7	-7.3	**13**	0.14	2.2	3.8
32 Other manufacturing	**16**	-0.16	1.0	-2.3	**1**	1.23	1.6	16.5
33 Repair and assembling of machinery and equipment	**18**	-0.49	2.1	-8.8	**14**	0.14	1.6	3.0

* The data on investments on the level of divisions of economic activities are provided from *Annual survey on investments in fixed assets of the Republic of Serbia*, which covers legal entities only.
For practical reasons, investments and the respective production growth were observed for the same period, i.e. calculated was the marginal capital coefficient for the same period. By following the relations of relevant aggregates in a longer period, partly neutralized were delayed effects that resulted from the time gap between the realization and activation of certain types of investments, so that technological marginal coefficient was not considered.

other non-metallic mineral products, Manufacture of machinery and equipment n.e.c, and Other manufacturing – recorded increased business profitability and simultaneously the largest share in the GVA of Manufacturing. Considerable progress was noted for all divisions, especially expressive for Other manufacturing, the division which increased its efficiency from -0.16 to 1.23 units, and then its share in the GVA of Manufacturing from 1% to 1.6%; simultaneously, on the rank list of efficiency it "made a jump" from the position 16 to the top (number one) position. Good results are notable for Manufacture of tobacco products that moved from the position number 13 to number 4, then for Manufacture of rubber and plastic products where the profitability was increased from 0.11 to 0.26 units and the share

in the GVA of Manufacturing from 6.4% to 8.1%, and for Manufacture of machinery and equipment n.e.c. (moving up from the position 19 to the position 2 on the rank list of efficiency).

- Certain divisions increased investment efficiency but decreased the share in the GVA of Manufacturing: Manufacture of beverages, Manufacture of fabricated metal products, except machinery, Manufacture of other transport equipment, Manufacture of furniture, Repair and assembling of machinery and equipment. As a consequence of negative growth rates from the previous period, investment does not produce results immediately and to certain extent the effect of investments in fixed assets overflows to the forthcoming period, since all mentioned divisions considerably increased the GVA growth rate in the period 2015-2019, i.e. passed from the negative to the positive business zone in the last five-year period.
- In certain cases, the coefficient of marginal efficiency may be regarded as an indicator of serious problems that an industry division encounters. This is applicable to already mentioned Manufacture of food products, however, also to Manufacture of motor vehicles, trailers and semi-trailers, where efficiency fell from 0.20 to -0.16 units, and the average GVA real growth rate from the high value of 27.7% fell to -5.8%. Manufacture of electrical equipment also recorded a notable fall of investment efficiency (from 0.26 to 0.02 units), and simultaneously – a slowed GVA growth rate – from the average 5.8% in the period 2010-2014 to 0.6% in the period 2015-2019. Negative results are also recorded for the division Manufacture of wood and products of wood, where efficiency decreased from 0.18 to -0.40 (fall on the rank list from the position 6 to the position 24). Efficiency decrease in these divisions is a warning signal of lagging in applying modern technologies in production processes, which could have unfavourable repercussions for economic dynamics if we consider that investments in these divisions do not return through increased value added, but on the contrary induce its fall.

The average interdependence of the GVA real growth and the investment performances in Manufacturing is shown in Figures 5 and 6 for the periods 2010-2019 and 2015-2019. The interdependence of these two variables undoubtedly indicates the real growth rate that can be gained though certain pace of investment. By comparative observation of these two diagrams, we can note the movement of efficiency coefficients value in various Manufacturing divisions in the last five-year period related to the whole period of observation, i.e. the grouping of the observed features around higher values on the scale of efficiency.

The favourable economic climate of the achieved macroeconomic stability and the new investment cycle in last five-year period were reflected through positive business performance of the section of Manufacturing. The increased effectiveness of the engaged capital input in the process of production generated a dynamic growth, so the newly created value of the total Manufacturing in the years observed was increased in real terms at the average interannual rate of 2.4% (by 1.6 p.p. faster if compared to the previous period). Almost three times increased production effectiveness of the invested capital when related to the observed post-crisis period, indicates not only the increased value of the investments volume, but also the upgraded qualitative business level gained through advancing technological component of the entire section, which is the fundamental, if not even of crucial importance premise of longstanding sustainable growth and development.

For the initially mentioned six divisions that are the starting point of this study (Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of electrical equipment; Manufacture of rubber and plastic products; Manufacture of basic metals; Manufacture of machinery and equipment n.e.c.; Manufacture of chemicals and chemical products) confirmed was a close relationship existing among inclusion in global value chains, investment profitability, and GVA and exports growth. Namely, in four divisions the effectiveness of investments was considerably increased:

- Manufacture of chemicals and chemical products: from 0.11 to 0.19
- Manufacture of rubber and plastic products: from 0.11 to 0.26
- Manufacture of machinery and equipment n.e.c.: from -0.52 to 0.81

Figure 5: Investment efficiency in Manufacturing section, 2010-2019

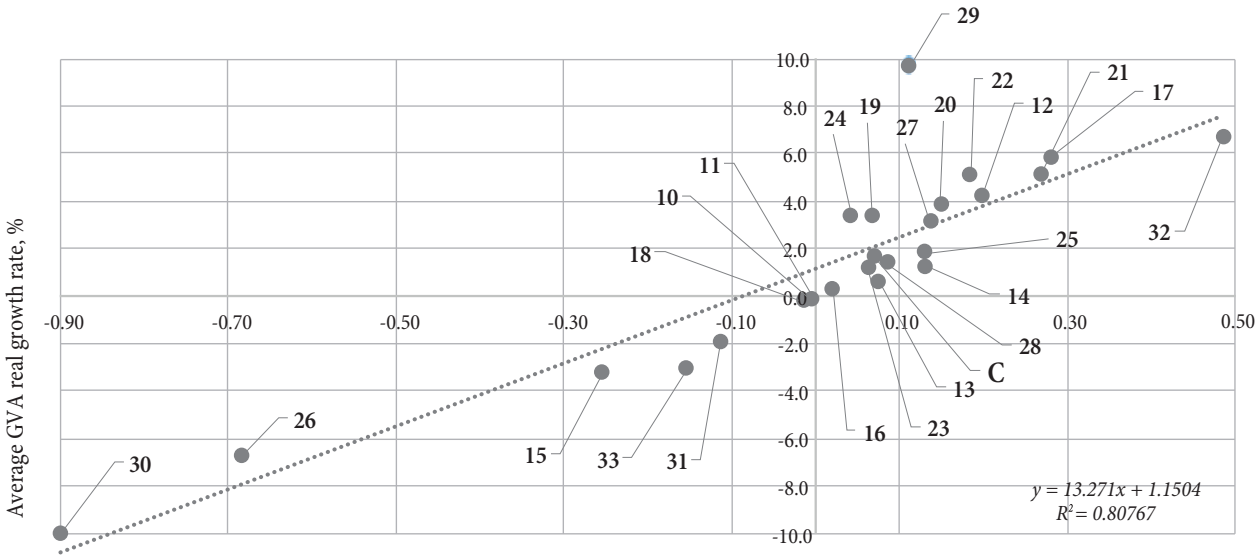
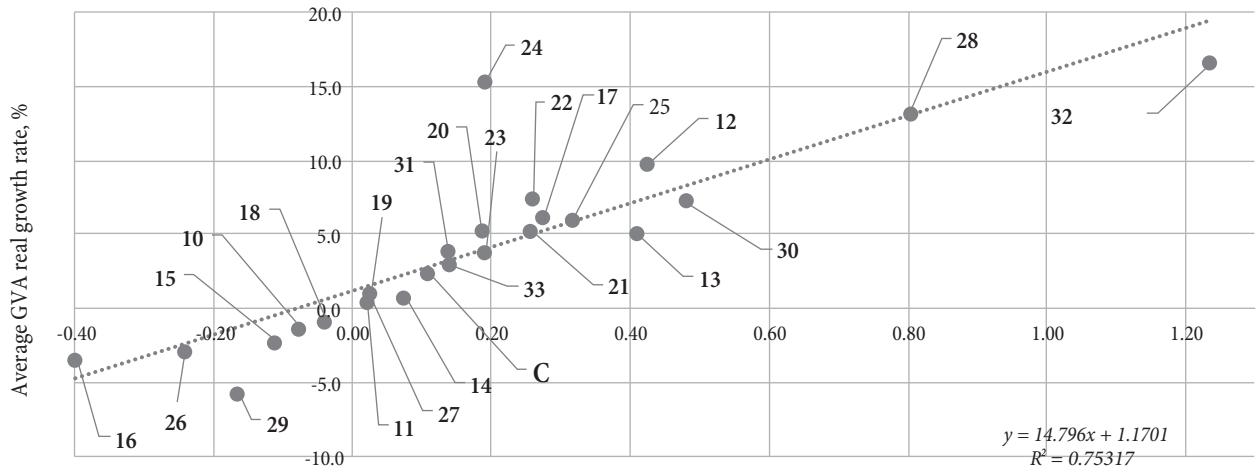


Figure 6: Investment efficiency in Manufacturing section, 2015-2019



Note: In diagram given are the codes of the Classification of activities for the respective economic divisions of the Manufacturing section*

* 10 Manufacture of food products
11 Manufacture of beverages
12 Manufacture of tobacco products
13 Manufacture of textiles
14 Manufacture of wearing apparel
15 Manufacture of leather and related products
16 Manufacture of wood and products of wood and cork, except furniture
17 Manufacture of paper and paper products
18 Printing and reproduction of recorded media
19 Manufacture of coke and refine petroleum products
20 Manufacture of chemicals and chemical products
21 Manufacture of basic pharmaceutical products
22 Manufacture of rubber and plastic products
23 Manufacture of other non-metallic mineral products
24 Manufacture of basic metals
25 Manufacture of fabricated metal products, except machinery
26 Manufacture of computers, electronic and optical products
27 Manufacture of electrical equipment
28 Manufacture of machinery and equipment n.e.c.
29 Manufacture of motor vehicles, trailers and semi-trailers
30 Manufacture of other transport equipment
31 Manufacture of furniture
32 Other manufacturing
33 Repair and assembling of machinery and equipment

• Manufacture of basic metals: from -0.10 to 0.19, with the simultaneous growth of their GVA and exports. On the contrary, for the divisions Manufacture of electrical equipment and Manufacture of motor vehicles, trailers and semi-trailers investment efficiency decreased: in the first from 0.26 to 0.02, and in the second from 0.20 to -0.16, while at the same time their GVA growth rate also noted fall, just as the absolute GVA amount expressed in value chain-linked volume measures.

However, for both divisions exports are still on the increase, which suggests that Serbia exports products with low value added and that the share of input in production is larger than the newly created value. Meanwhile, an option is to export stocks from the previous period, which also

indicates lagging and problems in production. Anyhow, these are the divisions that on long-term and medium-term basis present temptations for economic policy makers; since being capital intensive, they present the backbone of the Serbian exports sector. Therefore, the capital resources flows need to be adequately directed so to achieve the division restructuring towards higher investment and exports profitability.

Importance of exports of services and ICT sector evolution in the Serbian GDP

It is worthwhile stressing that the most rapidly growing capital efficiency in the entire economy was recorded for the sector of services, so-called professionally creative activities. A new progress paradigm, with the key elements being creativity, knowledge, originality, know-how, etc., recognizes these activities as potentially the major source of economic prosperity. Even the concept of growth and progress is changing, and the modern allocation of investments is directed towards increasing the share of intellectual property in the structure of fixed assets (software and R&D as the main composite elements), this inducing a powerful progress of activities where these resources are relatively more represented. Computer programming, Information service activities, and Scientific Research and Development reach the value of marginal coefficient of efficiency exceeding 1, which means they generate high GDP growth rates. Besides, these activities through the secondary expansion (of other economic activities) may become progress generators for the entire economy; therefore, investment in these divisions presents investment in future and should be the key point of clearly profiled development strategy.

Unlike other WB countries, where the growth of exports of services mainly results from the development of tourist trade (Albania and Montenegro), in Serbia the exports of services is grounded on the exports of information technologies, financial and business services – namely the sections (CA) that are not traditionally of exporting kind. The Serbian exports of IT services from 0.5% of GDP in 2007 reached the value of 2% of GDP in 2016, where Serbia got positioned as the regional focal point of the IT services production and exports. The initial moment was when in 2005 Microsoft development centre (MDCS) was established in Serbia, which attracted numerous eminent foreign IT companies in Serbia. Another important step was the introduction of the subject *Informatics* as compulsory in primary schools, as well as the increased entry quotas at IT university faculties by 20%. Thereby, the graduate students from these faculties (making more than one quarter of all graduates) established the critical mass of informatics talents.

With assistance from the EU and the World Bank, in 2011 the RS government established the Investment fund for financing start-up high-risk projects supporting science and technology innovations. Eventually, IT professionals and companies were granted tax reliefs and other fiscal benefits. So, administrative measures and assistance were shown as stimulative and productive in maximizing comparative benefits within the ICT sector.

In the period from 2010 to 2019 the share of the ICT sector[6] in the Serbian GDP increased from 3.6% to 4.7% (see Figure 7). At the same time, within the entire ICT sector the most expansive notable was the division 62 – Computer programming, consultancy and related activities, which reached the share of 2.05% GDP in 2019 (in 2010: 0.81%). The GVA of this division grew at an average annual rate of 11.9% in the period observed, while the GVA of the entire ICT sector grew at an average annual rate of 5.4%.

Moreover, based on the preliminary data of the SORS survey on structural business statistics/SBS, it could be noted that in 2020 the ICT sector expressed resistance to negative macroeconomic situation; namely, the quarterly

6 ICT sector according to the international definition (Eurostat, OECD) is composed of the following business activities/industries (NACE Rev. 2):
ICT Manufacturing
26.1 Manufacture of electronic components and boards
26.2 Manufacture of computers and peripheral equipment
26.3 Manufacture of communication equipment
26.4 Manufacture of consumer electronics
26.8 Manufacture of magnetic and optical media
Wholesale of information and communication equipment
46.5 Wholesale of information and communication equipment
ICT services
58.2 Software publishing
61 Telecommunications
62 Computer programming, consultancy and related activities
63.1 Data processing, hosting and related activities; web portals
95.1 Repair of computers and communication equipment

Figure 7: ICT sector share in GDP of the Republic of Serbia, 2010-2019, %

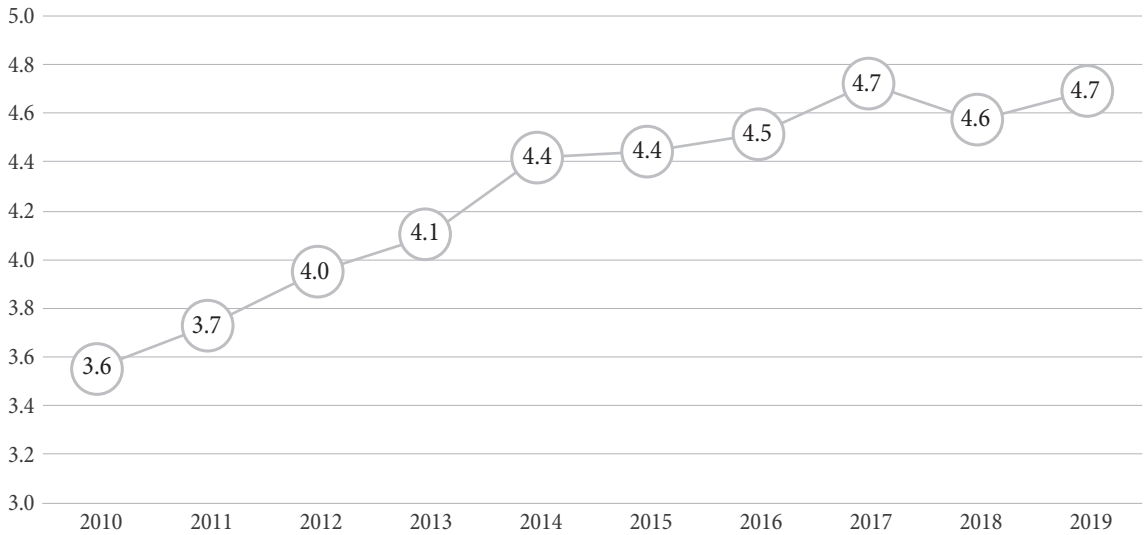


Table 4: ICT sector – registered employment, changes by quarters, %: 2020 to 2019*

ICT sector – total and components	Changes, %			
	1st qtr. 2020/ 1st qtr. 2019	2nd qtr. 2020/ 2nd qtr. 2019	3rd qtr. 2020/ 3rd qtr. 2019	4th qtr. 2020/ 4th qtr. 2019
ICT sector – total	**9.2**	**12.1**	**11.2**	**11.5**
ICT Manufacturing	***7.6***	***8.8***	***4.1***	***0.1***
Manufacture of electronic components and boards	16.5	9.2	-0.3	5.7
Manufacture of computers and peripheral equipment	3.7	9.9	6.3	2.9
Manufacture of communication equipment	6.3	8.5	7.8	4.5
Manufacture of consumer electronics	2.1	-3.1	0.8	-1.8
ICT Services	***9.3***	***12.4***	***11.8***	***12.4***
Wholesale of information and communication equipment	16.0	8.4	13.8	20.0
Software publishing	1.8	-1.3	-3.2	1.2
Telecommunications	0.9	3.6	7.6	10.0
Computer programming, consultancy and related activities	13.0	17.1	13.7	13.3
Data processing, hosting and related activities; web portals	22.6	24.0	20.1	18.2
Repair of computers and communication equipment	-5.3	-4.4	0.7	4.2

Source: Survey on registered employment, based on a combination of data from the Central Register of Compulsory Social Insurance (CROSO) and the Statistical Business Register (SPR).

data indicate that the ICT sector share in GDP gained the robust values of 5.4%, 5.6%, 5.1% and 5%, respectively by quarters 2020. According to the current estimations, this could imply that the ICT sector in 2020 even increased its share in GDP.

These movements are also backed up by the data on the ICT sector registered employment, which increased in 2020 when related to 2019 (see Table 4). Since the coronavirus pandemic accelerated the implementation of the 4th industrial revolution and "new normality" would be grounded on digitalization and automation, Serbia has a good chance in the post-pandemic period to resume the positive trend of the ICT sector evolution, and to make the best use of the comparative advantages in this domain.

Conclusion

The appearance and development of global value chains enormously reshaped the economic relief and at the same time provided a chance for the countries that earlier had been on the margin of the global economy to ensure their position in the new international division of labour and make use of it as a chance for development. Following the outbreak of 2008 global economic crisis their contraction

started, which is expected to go on as a consequence of the coronavirus pandemic. The process of "returning" production to their resident countries has already lasted for years and most probably will be accelerated, due to the sense of insecurity ruling the global economy, as well as because of the fall of prices of robots that proved to be an adequate substitute for human labour in certain industries' divisions. Serbia earned its standing in the global fragmentation of production and trade owing to its favourable geographic position, inexpensive inputs, relatively stable macroeconomic environment and solid education of the labour force. Serbia's exports results and integration in global value chains are most prominent in six Manufacturing divisions – Manufacture of motor vehicle and trailers, Manufacture of electrical equipment, Manufacture of rubber and plastic products, Manufacture of basic metals, Manufacture of machinery and equipment n.e.c., and Manufacture of chemicals and chemical products. Even though the exports are on the increase, the value added/GVA growth in certain divisions show falling trends (Manufacture of motor vehicle and trailers, Manufacture of electrical equipment), which may indicate unfavourable status in global value chains (at their bottom line), where value added is not created and only products' assembling is carried out. Considering Manufacture of food products, traditionally highly represented in the Serbian exports and production, in the ten-year period – from 2010 to 2019 – it recorded the fall of value added. This division also has extremely low investment efficiency, which further indicates its deeply rooted structural problems. The implications of the process of global value chains reduction for Serbia will depend upon the economic ambience, macroeconomic stability and investment in productive and attractive activities. However, in the future the Serbian economy has good chance to ground the entry into new markets on the progress of its ICT sector, which offers a solid platform for the development, having been structured for several last years. During the pandemic and in the post-pandemic period this sector, along with industry, has expressed its considerable resistance to shocks; therefore, public administration measures need to be directed towards its further expansion.

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PRINCIPAL COMPONENT ANALYSIS IN DETERMINING REPRESENTATIVE FINANCIAL RATIOS WITHIN NON-LIFE INSURANCE SECTOR IN SERBIA

Analiza glavnih komponenata u određivanju reprezentativnih finansijskih pokazatelja u sektoru neživotnih osiguranja u Srbiji

Abstract

The paper deals with the application of principal component analysis in determining financial ratios that are representative within non-life insurance sector. Starting from many financial indicators found in the literature in the field of insurance, the purpose of the study is to identify a smaller set of ratios that are most relevant for assessing the financial position and performance of non-life insurance companies in Serbia with a minimum loss of information. On the basis of financial reports of non-life and composite insurers in the period 2010-2019, we calculated 38 financial ratios, grouped into seven categories (capital adequacy, asset quality, reinsurance risk and performance, adequacy of technical reserves, profitability, liquidity and management soundness). Using parallel analysis and Velicer's minimum average partial test, we found that it is possible to explain 85% of variability of the initial set of ratios with six financial ratios. The obtained results can be used for the purposes of efficient financial analysis of individual insurance companies and the entire non-life insurance sector in Serbia.

Keywords: *non-life insurance, financial ratios, principal component analysis, Velicer's minimum average partial test, parallel analysis, principal component loadings.*

Sažetak

Predmet rada je primena analize glavnih komponenata u određivanju reprezentativnih finansijskih pokazatelja u sektoru neživotnih osiguranja. Cilj istraživanja je da se, polazeći od mnoštva finansijskih pokazatelja koji se susreću u literaturi u oblasti osiguranja, identifikuje manji skup pokazatelja koji su najrelevantniji za ocenu finansijskog položaja i performansi kompanija koje se bave poslovima neživotnih osiguranja u Srbiji, uz minimalan gubitak informacija. Na osnovu finansijskih izveštaja neživotnih i kompozitnih osiguravača tokom perioda 2010-2019. godine, izračunato je 38 finansijskih pokazatelja, koji su razvrstani u sedam kategorija (adekvatnost kapitala, kvalitet imovine, rizik i performanse reosiguranja, adekvatnost tehničkih rezervi, profitabilnost, likvidnost i kvalitet menadžmenta). Primenom paralelne analize i Velicerovog minimalnog prosečnog delimičnog testa, utvrđeno je da je sa svega šest finansijskih pokazatelja moguće objasniti 85% varijabiliteta inicijalnog skupa pokazatelja. Dobijeni rezultati mogu biti korišćeni u svrhe efikasne finansijske analize pojedinačnih osiguravajućih kompanija i celokupnog sektora neživotnih osiguranja u Srbiji.

Ključne reči: *neživotno osiguranje, finansijski pokazatelji, analiza glavnih komponenata, Velicerov minimalni prosečni delimični test, paralelna analiza, opterećenja glavnih komponenata.*

Introduction

Financial ratios as quantitative indicators calculated on the basis of data from corporate financial reports are widely used in the field of insurance. In the analysis of financial statements, they are applied for the purposes of assessing the liquidity, profitability and solvency of insurance companies, as well as projecting their future financial position and performance. Ratio analysis enables the identification of "strengths" and "weaknesses" of the company, as a basis for business and strategic decision-making. As a rough measure of risks to which insurance companies are exposed, including insurance risks, financial and operational risks, these indicators contribute to adequate risk management. Financial ratios are indispensable analytical tools in assessing the rating of insurers, as well as in the process of regulation and supervision of their business. They provide information on the soundness and performance not only of individual companies, but also of the entire insurance market, as well as its segments. Hence, a number of insurance stakeholders are interested in these indicators, including current and potential policyholders, investors, creditors, management, employees, business partners and government authorities.

The insurance business is characterized by a pronounced complexity, stochastic nature and strict regulation. Therefore, in addition to financial ratios that are common in other sectors, special ratios which take into account the specific characteristics of activities of insurance companies are applied in insurance. So far, a number of sets of financial ratios have been proposed for insurance companies by researches, rating agencies, insurance regulators and supervisors, as well as international institutions (such as CARAMELS set of indicators that are developed by the International Monetary Fund). Thereby, specific indicators are defined for life and non-life insurers, taking into account their substantially different risk exposures and business models. Nevertheless, there is a significant degree of overlap between many indicators in terms of their meaning and interpretation. On the other hand, it is logical to assume that all defined indicators are not equally relevant in all insurance markets, given the level of development and the structure of these markets. Also, the relative importance of individual indicators changes over time due to changes in the macroeconomic environment and regulatory regulations. This raises the question of how to choose from a multitude of financial ratios those that are relevant to a particular insurance market in a given period.

The paper deals with the application of principal component analysis in determining financial ratios that are representative within non-life insurance sector. This multivariate statistical technique permits explanation of relationships existing between a large number of ratios with respect to their common underlying factors. Starting from many financial ratios that are found in the literature in the field of insurance, the aim of this paper is to identify a smaller set of ratios that are most relevant for assessing the financial health of non-life insurance companies in Serbia while retaining the maximum amount of information.

The remainder of the paper is structured as follows. The first section provides an overview of the literature related to the use of factor and principal component analysis with financial ratios in different sectors. Research methodology is described in the second section, followed by explanation of sample selection, data sources and descriptive statistics of research variables in the third section. The research results are presented and discussed in the fourth section.

Literature review

Attempts to identify representative financial ratios are found in several empirical researches conducted in different sectors. Pinches et al. [22] were the first to employ factor analysis in order to develop empirically-based classifications of financial ratios used in industrial organizations. Their pioneering study served as a starting point for later research aimed at grouping of financial ratios and reducing their number for the purposes of more efficient and focused analysis of corporate financial statements in particular sectors.

Öcal et al. [19] used factor analysis to determine interrelationships between various financial ratios on a sample of Turkish construction companies during the period 1997-2001. Starting from 25 ratios, they found five underlying factors. Similarly, Vergara & Serna [27]

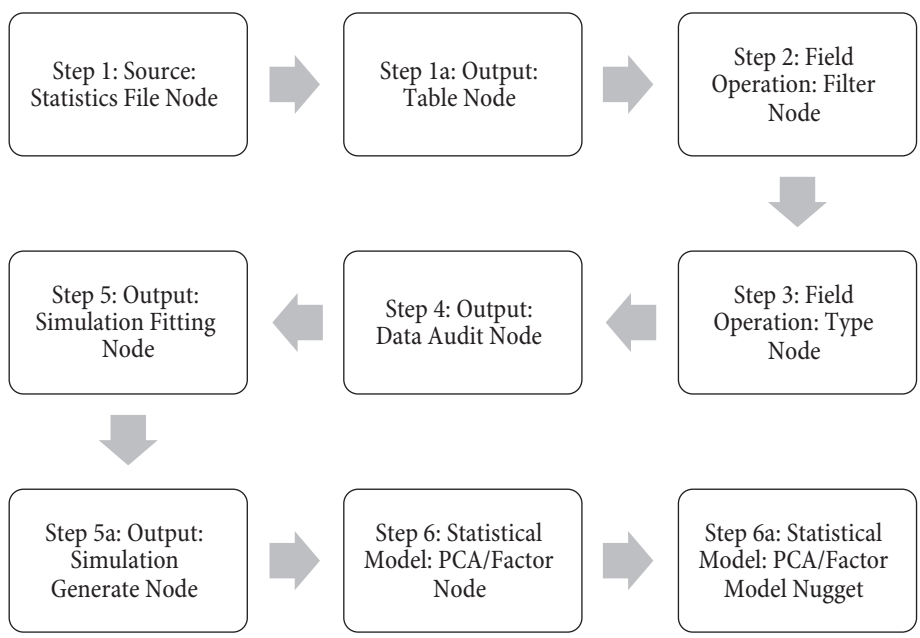
conducted factor analysis on the financial ratios of companies in the Colombian construction sector for the period 2000-2014. They identified four underlying factors explaining 88% of the total variability of 13 conventional financial ratios. De et al. [4] applied factor analysis on 25 financial ratios of selected companies from Indian cement industry to derive eight underlying factors. Yap et al. [29] investigated the application of principal component analysis in the selection of financial ratios that are specific for the consumer product and trading and services sectors in Malaysia. From an initial set of 28 ratios, seven and nine ratios, explaining around 80% of the ratio variances, were selected for the two sectors. Lukason & Laitinen [16] used the factor analysis on 11 financial ratios of bankrupted manufacturing firms from 15 European countries and found five underlying factors. Yoshino & Taghizadeh-Hesary [30] used principal component analysis to obtain a set of ratios useful for predicting a probability of default for a sample of small and medium-sized enterprises in Asia. In order to construct a synthetic financial performance index, Sanz et al. [24] applied principal component analysis on financial ratios of EU-28 companies operating in the publishing sector.

Comparable research in the financial services sector is relatively rare. On the example of the Greek banking sector, Dimitropoulos et al. [5] obtained four risk factors from 11 financial ratios by principal component analysis. A study carried out by Armeanu & Lache [1] derived three principal components from eight financial variables measuring financial strength of insurance companies in Romania. Erdemir & Tatlidil [6] used principal component analysis to reduce the number of input and output variables in data envelopment analysis of efficiency of Turkish insurance companies. To our knowledge, principal component analysis has not been applied to financial ratios of insurance companies in Serbia, and therefore this study is the first attempt.

Research methodology

The process of applying the principal components analysis is a complex data mining procedure [28, p.520], which can be shown in Figure 1. Inside it a stream consisting of several steps is presented. The first step defines the data source as well as the format in which the data is stored. In the next step, the loaded data is presented using a table, so that it is possible to perform a visual screening of the data, in terms of the first data check. In the next step of the data mining stream, the operation of filtering variables is applied, in the sense that only the variables from the data set that refer to the financial ratios go into

Figure 1: Data Mining Principal Component Modelling Stream



Source: The result of the analysis conducted by the authors

the further course of the analysis. In step 3, the appropriate measurement scale is determined, for the financial ratios to be analysed. The basic descriptive statistical analysis of all analysed financial ratios is performed in the next step: data audit node.

Due to the fact that the analysis of the principal components is based on the correlation matrix of the analysed financial ratios, we construct it using step number 5, which consists of two nodes (simulation fitting, as well as simulation generate node) [15, p.99]. In the last sixth step, we set up the procedure for data reduction in data mining. Within this step, care should be taken, because both the principal component analysis and the factor analysis are within the same procedure. So one should pay attention, in the sense, that the principal component analysis is actually applied. The result of statistical modelling is given in the last step, and based on it, it will be possible to determine which are the representative financial ratios.

Representative financial ratios can be identified using principal component analysis for dimensional reduction purposes. In the process of dimension reduction, it is determined which financial ratio has a high loading on the extracted principal components. For this reason, in the principal component analysis process, a principal component loadings matrix needs to be formed. The first stage in the analysis of principal components is, of course, detecting whether a sufficient sample size is available, as well as whether the collected data are suitable for the use of principal component analysis.

For sample size, it is recommended that the number of observation should be at least five times larger than the number of variables, while the absolute minimum is 100 observations. When examining whether it is appropriate to apply a dimensional reduction procedure to the data collected, a Kaiser-Mayer-Olkin sample adequacy measure could be used. The given measure is defined in the range from 0 to 1, and if the value of the Kaiser-Mayer-Olkin measure is greater than 0.5, then it is appropriate to apply a dimensional reduction procedure. The given measure is calculated by the formula

$$KMO = \frac{\sum\sum_{i\neq j} r_{ij}^{\ 2}}{\sum\sum_{i\neq j} r_{ij}^{\ 2} + \sum\sum_{i\neq j} \text{partial\_r}_{ij}^{\ 2}} \qquad (1)$$

where r_{ij} denotes the correlation coefficient between the i^{th} and j^{th} analysed financial ratios, and $partial\_r_{ij}$ denotes the partial correlation coefficient between the the i^{th} and j^{th} analysed financial ratios. Otherwise, the partial correlation coefficient between two financial ratios represents the (ordinary) correlation coefficient when the influences of all other financial ratios are excluded.

Also, to check whether the given data are suitable for the use of the data reduction procedure, Bartlett's test of sphericity can be used, which tests the null hypothesis that the correlation matrix of financial ratios is an identity matrix. The formula for test statistics is

$$x^2 = \frac{2p-6n+11}{6} \cdot \ln|R| \qquad (2)$$

where p represents the number of financial ratios, n is the number of observations, and $|R|$ is the determinant of the correlation matrix of financial ratios.

The next step, which is crucial, is to determine the number of extracted principal components. This is important because the correct statistical methodology that determines the number of extracted principal components is usually not implemented in well-known and popular statistical softwares. They usually have two standard approaches: Kaiser's criterion "eigenvalue greater than 1" or Cattel's scree plot. However, these two approaches usually yield a larger number of extracted principal components. For that reason, Horn's parallel analysis will be used, as well as Velicer's minimum average partial test. In parallel analysis, the initial eigenvalues of the principal components over the observed sample data are compared with the eigenvalues over the random data sets. Namely, a large number (for example 1000) of data sets of random numbers is formed which are of the same dimensions as the actual data set. Then, for each data set with random numbers, eigenvalues are calculated for each principal component, and then these calculated eigenvalues (which has, for example, 1000 for each principal component) are averaged. Finally, the values of real eigenvalues are compared with mean random data eigenvalues. The rule is: the principal components are extracted, where the initial eigenvalues are greater than the mean random data eigenvalues. Otherwise, when calculating eigenvalues, it comes down to a typical problem of eigenstructure.

The task is to create an eigenstructure over the sample data matrix. If the matrix of realized data is denoted by X and its standardized form by Z, then finding the eigenstructure of the matrix X is reduced to finding the eigenstructure of its correlation matrix R, because $R = \frac{1}{n-1} Z^T Z$ where the symbol ^{T} denotes operation transposed matrix. The eigenstructure of the correlation matrix is $R = UDU^T$, U represents the matrix of eigenvectors of R, and D the matrix of eigenvalues of R.

Velicer's minimum average partial procedure is the calculation of partial correlation coefficients, as follows. First, the correlation matrix R is calculated based on the sample data. Then, based on the given correlation matrix, we perform an analysis of the principal components with only one extracted principal component. Subsequently, a matrix of partial correlation coefficients is created, which is obtained when the influence of the first principal component is excluded from the observed variables. Then, the average of the squared partial correlation coefficients is calculated. The given procedure is repeated, but now two principal components are extracted, and so on. Finally, the number of extracted principal components is determined by finding the minimum average of the squared partial correlation coefficients. So, it is determined for which number of extracted principal components the minimum value of the average of the squared partial correlation coefficients is obtained.

Finally, let us point out how principal components loadings are calculated, which is essential for determination of representative financial ratios. Thereby, it should be noted that in the analysis of principal components, principal components are not correlated with each other, and financial ratios are presented in a standardized form. Under these conditions, principal components loadings represent the correlation coefficients between financial ratios and principal components. Thus, the principal components loadings matrix can be calculated by formula

$$A = \frac{1}{n-1} \cdot Z^T C \qquad (3)$$

where C represents the matrix of standardized scores of principal components, which are calculated according to formula $C = ZUD^{-1/2}$ [26, p.275]. If we replace the matrix C with the formula for the matrix A, we get $A = \frac{1}{n-1} ZTZUD^{-1/2}$ and that is (based on the previous equations) equal to $A = RUD^{-1/2}$. Since R is represented as $UDUT$, it follows that the matrix A is now equal to $UDUTUD^{-1/2}$. Because the matrix U is orthogonal, ie UTU, it follows that

$$A = UDID^{-1/2} = UDD^{-1/2} = UD^{1/2}. \qquad (4)$$

So with the help of already calculated eigenvectors and eigenvalues of the correlation matrix, we are able to calculate the principal components loadings matrix.

Sample selection and descriptive statistics

The non-life insurance sector accounted for 77% percent of the total insurance premium generated on the Serbian insurance market in 2019. Units of observation in our analysis were all 12 insurance companies that constitute this sector, including 6 companies providing exclusively non-life insurance, and 6 composite insurers, providing life and non-life insurance. Thus, the study covered the entire population, not just the sample.

Initially we identified 38 financial ratios which are generally considered relevant to insurance companies, including core set of CARAMELS indicators [3], ratios recommended in the relevant literature [2, 21], as well as ratios used worldwide for supervisory purposes [14] or for assigning credit ratings [17]. The ratios are classified in seven main categories, as shown in Table 1.

Capital adequacy ratios show whether the insurer's capital is sufficient to cover the risks that threaten its business. They link equity to an appropriate position in the balance sheet or income statement that reflects risk exposure. In non-life insurance, written premium on net or gross basis is used as a measure of insurance risk exposure (s1, s4), while the value of total assets approximates exposure to financial risks (s2). In addition, capital adequacy may be impaired with excessive growth of gross premium written (s3), as well as with the oscillations of capital itself (s5).

Asset quality ratios provide a deeper insight into insurer's exposure to investment risks. They are calculated as the share of high-risk assets in insurer's capital (aq1, aq5, aq6) or total assets (aq2, aq3, aq4).

Reinsurance is certainly the most important risk management instrument for insurance companies. However, it implies the possibility that the reinsurer will fail to meet its obligations to the insurer. Low share of net written premium in gross premium written (rpr1), as well as high share of reinsurance reserves in capital (rpr2) or total assets (rpr4) indicate the presence of the reinsurance credit risk. The share of claims paid by reinsurers in total claims (rpr3) is used as a measure of reinsurance performance.

Adequacy of technical reserves, and primarily of loss reserves, is a prerequisite for timely settlement of insurers' obligations to policyholders. From the aspect of preserving the solvency of insurers, it is desirable to have as large technical reserves as possible compared to capital (atr1), premiums (atr2, atr3, atr4) and claims paid (atr5).

The key sources of insurer profit are underwriting business and investment business. The basic underwriting performance indicator is combined ratio (p1) as the sum of loss ratio (net incurred claims / net earned premium) and expense ratio (operating expenses / net earned premium). The share of loss adjustment expenses in net losses paid is also important for non-life insurers' profitability (p9). Investment performance indicators take into account the relative size of net investment income (p2, p3), or investment expenses (p8). Finally, general profitability indicators - return on equity (p4), return on revenue (p5) and derived from it return on premiums (p6), as well as return on assets (p7) are also relevant for insurance companies.

Liquidity ratios reflect the amount of the liquid assets in relation to liabilities (l2, l3, l5, l6, l7), total assets (l4) or claims and expenses paid (l1). Thereby, liquid asset is defined in different ways, starting from cash and cash equivalents, through invested assets to current assets less inventories.

Management soundness indicators represent a rough measure of insurers' exposure to operational risks, among which weaknesses and failures of management stand out. Quantification of this risk is difficult due to lack of data, so it is approximated by the share of expenses in gross premiums written (ms1, ms2).

Financial ratios from the initial set are calculated on the basis of balance sheets and income statements of analysed insurance companies for years 2010 to 2019, which are gathered from the website of the National Bank of Serbia [18]. Table 2 shows the descriptive statistics of all 38 financial ratios included in the analysis of principal components. From the statistical indicators, the mean values as well as the standard deviations are shown. Also, the

Table 1: Financial ratios used in Data Mining Principal Component Analysis

Category/ Name	Formula
CAPITAL ADEQUACY	
s1	Net written premium / Capital
s2	Capital / Total assets
s3	Growth in net written premium
s4	Gross premium written / Capital
s5	Change in Shareholders' equity
ASSET QUALITY	
aq1	Affiliated investments / Capital
aq2	(Real estate + unquoted equities + debtors) / Total assets
aq3	Equities / Total assets
aq4	Real estate / Total assets
aq5	(Equities + real estate) / Capital
aq6	Intangibles / Capital
REINSURANCE RISK AND PERFORMANCE	
rpr1	Net written premium / Gross premium written
rpr2	Reinsurance reserves / Capital
rpr3	Claims paid by reinsurers / Total claims
rpr4	Reinsurance reserves / Total assets
ADEQUACY OF TECHNICAL RESERVES	
atr1	Technical reserves / Capital
atr2	Loss reserves / Net premiums earned
atr3	(Capital + technical reserves) / Net written premium
atr4	Technical reserves / Gross premium written
atr5	Net technical reserves / Average of net claims paid in last 3 years
PROFITABILITY	
p1	Combined ratio (loss ratio + expense ratio)
p2	Net investment income / Net earned premium
p3	Net investment income / Average invested assets
p4	Return on equity - ROE (Net income / Capital)
p5	Return on revenue (Net income / (Premium income + investment income + other income))
p6	Return on premiums (Net income / Gross premiums written)
p7	Return on assets - ROA (Net income / Total assets)
p8	Investment expenses / Gross premiums written
p9	Loss adjustment expenses / Net losses paid
LIQUIDITY	
l1	(Cash + invested assets) / Claims and expenses paid
l2	Liabilities / (Current assets less inventories)
l3	(Current assets less inventories) / Current liabilities
l4	(Current assets less inventories) / Total assets
l5	(Cash + invested assets) / (Unearned premium reserve + loss reserve)
l6	Cash and cash equivalents / Current liabilities
l7	(Current assets less inventories) / Technical reserves
MANAGEMENT SOUNDNESS	
ms1	Operating expenses / Gross premiums written
ms2	Personnel expenses / Gross premiums written

Source: The result of the analysis conducted by the authors.

sample size for each financial ratio is shown. It is natural to expect the sample size to be 120, as we have collected data for all 12 insurance companies for the last 10 years. However for one insurance company, there are data for the last 8 years, since it started operating in 2012, so the sample size for each financial ratio is 118.

Analysing the last column in Table 2, which shows the missing data, we see that for 3 financial ratios, there is 1 missing data, which is less than 1%. Regarding the modern methodology for solving missing data in the analysis of principal components, it is given in [7, p.48]. Also in the material [25, p.97] it is suggested that if the percentage of missing data is less than 5%, the given problem can be solved by traditional methods, that is, either by deleting the incomplete observation, or replacing the missing value with the sample average of financial ratio.

Table 2: Descriptive Statistics of Financial ratios

	Mean	Std. Deviation	Analysis N	Missing N
s1	204.1396%	177.60902%	118	0
s2	29.4879%	18.37983%	118	0
s3	11.1799%	32.50709%	118	1
s4	237.1124%	188.84746%	118	0
s5	18.7251%	65.59689%	118	1
aq1	3.7448%	8.54564%	118	0
aq2	22.6023%	15.96164%	118	0
aq3	2.7376%	6.90531%	118	0
aq4	14.0186%	13.16855%	118	0
aq5	58.5875%	57.00308%	118	0
aq6	3.6087%	8.24254%	118	0
rpr1	84.8310%	18.24678%	118	0
rpr2	20.5800%	37.22054%	118	0
rpr3	10.8755%	12.86955%	118	0
rpr4	4.7781%	7.68097%	118	0
atr1	319.3209%	252.36706%	118	0
atr2	47.6803%	27.53626%	118	0
atr3	279.5808%	184.78260%	118	0
atr4	90.9365%	25.40672%	118	0
atr5	250.0197%	89.26436%	118	1
p1	98.9872%	31.79686%	118	0
p2	7.5288%	27.11162%	118	0
p3	3.9473%	16.90049%	118	0
p4	-3.1904%	64.13051%	118	0
p5	1.1236%	23.98857%	118	0
p6	0.2397%	30.52644%	118	0
p7	0.3366%	8.95121%	118	0
p8	5.0227%	27.03663%	118	0
p9	13.7598%	16.89776%	118	0
l1	300.9626%	325.97969%	118	0
l2	144.4977%	147.03405%	118	0
l3	378.0983%	919.22841%	118	0
l4	63.5955%	23.19596%	118	0
l5	737.5748%	1757.91613%	118	0
l6	17.7281%	30.83298%	118	0
l7	119.9347%	91.27676%	118	0
ms1	35.7607%	11.39627%	118	0
ms2	5.6707%	4.65506%	118	0

Note: For each variable, missing values are replaced with the variable mean.
Source: The result of the analysis conducted by the authors using IBM SPSS Statistics 26 software.

Empirical results

Before applying the analysis for data reduction, it is necessary to first examine whether the assumptions for the given analysis are met. For this purpose, the Kaiser-Mayer-Olkin measure of sample adequacy is applied [8, p.137], as well as Bartlett's test of sphericity [23, p.341]. As Table 3 shows, the value of Kaiser-Meyer-Olkin statistics is 0.6 (ie greater than 0.5), so it is appropriate to apply the data reduction analysis to the given data.

Table 3: Kaiser-Meyer-Olkin Measure and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.601
Bartlett's Test of Sphericity	Approx. Chi-Square	7756.355
	df	703
	Sig.	0.000

Source: The result of the analysis conducted by the authors using IBM SPSS Statistics 26 software.

In Bartlett's test, the null hypothesis represents that the analysed variables are uncorrelated with each other (because it is assumed that the correlation matrix is equal to the unit matrix), so then it makes no sense to perform an analysis to reduce the data. In Table 3, we note that the *p-value* in a given test is less than 5%, so we reject the null hypothesis. After determining that it is appropriate to apply data reduction analysis, ie principal component analysis, over the analysed data, the next task would be to determine the exact number of principal components to be extracted using Velicer's Minimum Average Partial Test, as well as Parallel Analysis [10, p.242].

To apply the parallel analysis, it is necessary to compare the value of initial eigenvalues which is in the second column called Total in Table 4; with the value mean of random data eigenvalues located in the second column of Table 5.

Table 4: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.586	19.964	19.964	7.586	19.964	19.964
2	6.457	16.991	36.955	6.457	16.991	36.955
3	4.490	11.815	48.770	4.490	11.815	48.770
4	3.884	10.221	58.992	3.884	10.221	58.992
5	2.814	7.404	66.396	2.814	7.404	66.396
6	2.222	5.848	72.244	2.222	5.848	72.244
7	1.599	4.209	76.453			
8	1.356	3.569	80.022			
9	1.088	2.862	82.884			
10	0.971	2.554	85.438			
11	0.888	2.337	87.775			
12	0.869	2.286	90.062			
13	0.831	2.186	92.247			
14	0.578	1.522	93.769			
15	0.483	1.272	95.041			
16	0.320	0.842	95.883			
17	0.282	0.741	96.624			
18	0.249	0.654	97.279			
19	0.201	0.529	97.808			
20	0.196	0.515	98.323			
21	0.148	0.391	98.714			
22	0.111	0.291	99.005			
23	0.089	0.233	99.238			
24	0.077	0.204	99.442			
25	0.045	0.119	99.561			
26	0.034	0.090	99.651			
27	0.033	0.087	99.737			
28	0.029	0.076	99.814			
29	0.017	0.045	99.859			
30	0.016	0.042	99.901			
31	0.011	0.029	99.930			
32	0.008	0.022	99.952			
33	0.005	0.014	99.966			
34	0.004	0.012	99.978			
35	0.004	0.010	99.988			
36	0.003	0.008	99.996			
37	0.001	0.002	99.998			
38	0.001	0.002	100.000			

Note: Extraction Method: Principal Component Analysis.
Source: The result of the analysis conducted by the authors using IBM SPSS Modeler 18.0 software.

Table 5: Random Data Eigenvalues and Average Partial Correlations

Root/	Random Data Eigenvalues		Average Partial Correlations	
Eigenvalues	Means	95 Percentile	squared	power4
0			0.0851	0.0355
1	2.2820	2.4607	0.0943	0.0354
2	2.1108	2.2279	0.1033	0.0380
3	1.9885	2.0977	0.0875	0.0246
4	1.8786	1.9684	0.0875	0.0253
5	1.7831	1.8665	0.0751	0.0181
6	1.6979	1.7679	0.0682	0.0151
7	1.6184	1.6875	0.0594	0.0116
8	1.5436	1.6090	0.0601	0.0121
9	1.4722	1.5327	0.0634	0.0128
10	1.4076	1.4645	0.0608	0.0124
11	1.3435	1.3983	0.0599	0.0136
12	1.2836	1.3397	0.0696	0.0169
13	1.2254	1.2800	0.0756	0.0189
14	1.1681	1.2212	0.0758	0.0179
15	1.1154	1.1630	0.0821	0.0201
16	1.0636	1.1130	0.0852	0.0221
17	1.0141	1.0595	0.0896	0.0230
18	0.9659	1.0142	0.0970	0.0255
19	0.9190	0.9599	0.0973	0.0286
20	0.8753	0.9177	0.1153	0.0363
21	0.8317	0.8740	0.1230	0.0430
22	0.7889	0.8309	0.1387	0.0513
23	0.7484	0.7891	0.1291	0.0439
24	0.7079	0.7477	0.1228	0.0412
25	0.6689	0.7090	0.1324	0.0443
26	0.6314	0.6698	0.1475	0.0528
27	0.5940	0.6329	0.1465	0.0594
28	0.5585	0.5941	0.1501	0.0552
29	0.5232	0.5584	0.1599	0.0645
30	0.4884	0.5232	0.1873	0.0857
31	0.4544	0.4900	0.2151	0.1060
32	0.4213	0.4575	0.2325	0.1205
33	0.3892	0.4226	0.2822	0.1671
34	0.3553	0.3883	0.4103	0.2750
35	0.3229	0.3570	0.6408	0.5179
36	0.2900	0.3217	0.5161	0.4219
37	0.2544	0.2860	1.0000	1.0000
38	0.2144	0.2506		

Source: The result of the analysis conducted by the authors using IBM SPSS Modeler 18.0 software.

The rule in parallel analysis is: extract all those principal components for which the value of initial eigenvalues from column two of Table 4 is greater than the value mean of random data eigenvalues (which is given in column two of Table 5).

The Velicer's minimum average partial test creates the average of the squares of the partial correlation coefficients. Partial correlation coefficients are created in such a way that the influence of the first principal component is excluded from the analysed financial ratios. Then, the averages of the squares of partial correlation coefficients are formed. Now, the partial correlation coefficients are created in such a way that the influence of the first and second principal components is excluded from the analysed financial ratios. And so on. The obtained averages of the squares of the partial correlation coefficients are given

in column 4 of Table 5. This test determines the optimal number of extracted principal components, by determining the minimum in the fourth column. The minimum in the mentioned column is in the row where eigenvalue equals 7, which represents the number of extracted principal components.

So, by applying the previous two rules, the number of extracted principal components would be 6 (or 7). If the values of initial eigenvalue for each principal component are displayed on the graph, we get a scree plot, which is represented by Figure 2. On the scree plot we see that the values of the initial eigenvalues of the first 6 (or 7) principal components are on the steep slope of the broken line. If we apply the Kaiser's criterion, then we would extract the first 9 principal components; while there is no clear solution for the implementation of the scree test here, because the line connecting the values of the initial eigenvalues is broken in several places (and it needs to be broken only in one place).

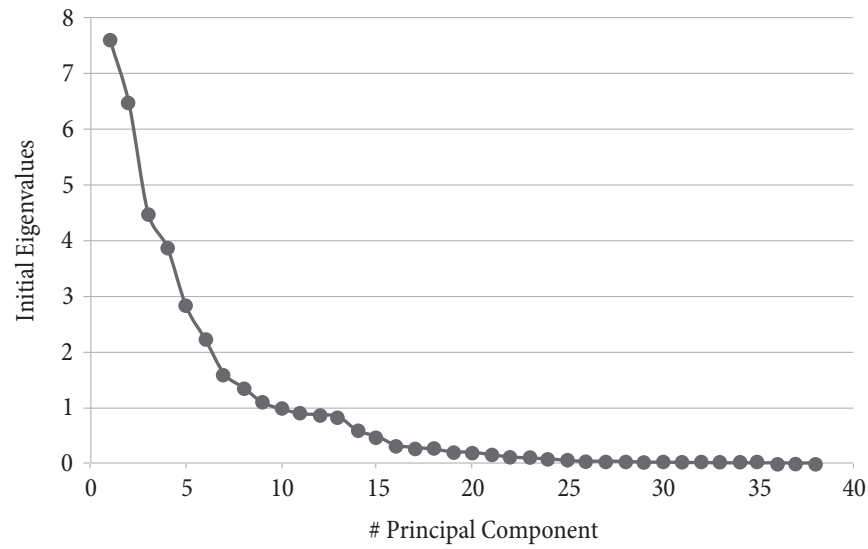
After determining how many principal components to extract, the next step would be to create principal component loadings matrix (Table 6). Values within the given matrix represent the intensity of loadings of each extracted principal component according to each financial ratio included in the analysis. Representative financial ratios are determined by detecting those financial ratios, which are the maximum loaded by the extracted principal components.

The extracted first principal component loads the financial ratio ms1 the most, so that it represents the first representative financial ratio. It should be noted that the maximum load is observed in absolute terms. The extracted second principal component loads the financial ratio s2 the most (in the absolute sense), so that it represents the second representative financial ratio. We arrive at the third representative financial ratio, in a similar way that is, by determining the financial ratio that is most (in absolute terms) loaded by the third principal component. The given financial ratio is aq4. The extracted fourth principal component (in absolute terms) loads the financial ratio rpr4 the most, which also becomes the fourth representative financial ratio. The penultimate extracted principal component loads the p1 financial ratio the most (in absolute amount). The last extracted principal component loads the financial ratio l4 the most.

Table 7 shows the representative financial ratios, which were obtained by applying the analysis of principal components. By analysing the first column of Table 7, it can be seen that all representative financial ratios are from different categories. We also see that the six representative financial ratios, compared to a total of 38 financial ratios analysed, represent a large reduction in data, amounting to almost 85%.

The representativeness of ratio of operating expenses to gross premiums written (ms1) can be explained by the fact that motor third-party liability insurance has a

Figure 2: Scree Plot



Source: The result of the analysis conducted by the authors.

Table 6: Principal Component Loadings Matrix

	Component					
Ratios	1	2	3	4	5	6
s1	-0.331	0.711	-0.369	0.178	0.358	0.133
s2	-0.194	-0.777	0.329	-0.279	0.195	0.073
s3	0.138	0.097	-0.013	-0.034	-0.102	0.166
s4	-0.278	0.715	-0.435	0.082	0.393	0.072
s5	0.127	0.020	-0.012	0.007	-0.278	0.013
aq1	-0.092	0.154	0.250	0.097	-0.062	-0.340
aq2	-0.710	-0.050	0.578	0.024	0.032	-0.034
aq3	-0.281	-0.249	0.491	0.104	0.222	-0.197
aq4	-0.690	-0.124	0.586	0.136	-0.007	0.052
aq5	-0.648	0.375	0.215	0.253	0.288	0.129
aq6	-0.200	0.340	-0.348	-0.045	0.435	0.027
rpr1	-0.361	0.280	0.278	0.667	-0.307	0.139
rpr2	0.125	0.251	-0.327	-0.633	-0.122	-0.160
rpr3	0.302	-0.007	-0.372	-0.517	0.241	-0.279
rpr4	0.261	-0.018	-0.262	-0.765	-0.046	-0.150
atr1	0.033	0.611	-0.565	0.285	0.311	-0.096
atr2	-0.198	0.605	-0.075	-0.355	-0.387	0.055
atr3	0.566	-0.637	-0.294	0.025	0.177	0.016
atr4	-0.383	0.612	0.040	-0.233	-0.384	0.144
atr5	0.069	0.263	0.000	-0.144	-0.168	0.463
p1	-0.241	-0.250	-0.115	0.010	0.512	-0.116
p2	0.729	0.424	0.358	0.096	0.303	0.060
p3	0.560	0.527	0.475	-0.039	0.358	0.074
p4	0.462	-0.278	0.475	-0.165	-0.495	-0.187
p5	0.753	0.350	0.497	-0.106	0.142	0.035
p6	0.723	0.392	0.513	-0.037	0.194	0.064
p7	0.720	0.293	0.576	-0.120	0.031	0.014
p8	-0.522	-0.495	-0.524	0.143	-0.377	-0.104
p9	0.402	-0.120	-0.117	0.545	-0.188	0.205
l1	0.657	-0.417	-0.291	0.415	0.078	-0.064
l2	0.182	0.138	-0.109	0.422	0.028	-0.708
l3	0.468	-0.315	-0.203	0.472	-0.072	0.393
l4	0.191	-0.011	-0.235	-0.245	-0.113	0.765
l5	0.540	-0.312	-0.231	0.638	-0.044	0.110
l6	-0.061	-0.543	0.128	0.108	0.464	0.136
l7	0.018	-0.608	-0.081	-0.443	0.319	0.401
ms1	-0.814	0.072	0.276	0.026	0.113	0.211
ms2	-0.378	-0.675	0.193	-0.221	0.368	0.008

Note: Extraction Method: Principal Component Analysis. 6 components extracted.
Source: The result of the analysis conducted by the authors using IBM SPSS Modeler 18.0 software.

predominant share in the non-life insurance premium in the analysed market. In this type of insurance, there is a problem of excessive acquisition costs that exceed the overhead allowance, as part of the gross premium intended to cover them. Hence, the relative amount of operating expenses is especially important from the aspect of measuring management soundness.

The choice of a combined ratio (p1) as representative of the non-life insurance sector is expected, as it is a

Table 7: Representative financial ratios based on Data Mining Principal Component Analysis

Category	Name	Formula
Management soundness	ms1	Operating expenses / Gross premiums written
Capital adequacy	s2	Capital / Total assets
Asset quality	aq4	Real estate / Total assets
Reinsurance risk and performance	rpr4	Reinsurance reserves / Total assets
Profitability	p1	Combined ratio (loss ratio + expense ratio)
Liquidity	l4	(Current assets - inventories) / Total assets

Source: The result of the analysis conducted by the authors.

summary indicator of non-life underwriting profitability, reflecting the sufficiency of net earned premiums to cover net incurred claims and operating expenses. Any analysis of the performance of non-life insurers without the combined ratio would be incomplete. It is also logical to find a liquidity ratio (l4) among the representative indicators for the non-life insurance sector, having in mind the short-term nature of the sources of funds and liabilities of non-life insurers.

The representativeness of the ratio of real estate to total assets (aq4) stems from the negligibly low presence of other forms of high-risk assets (such as equities) in insurers' assets, primarily due to the underdevelopment of the domestic capital market. Therefore, it is not reasonable to expect that the calculation of other asset quality ratios will significantly contribute to the assessment of the financial position of non-life insurers operating in Serbia.

The share of net written premium in gross premium written is commonly used to measure reinsurance risk. However, the interpretation of this ratio is complicated and multi-dimensional: a low value indicates a pronounced reinsurance risk, while a high value implies a pronounced insurance risk. The conducted analysis shows that the share of reinsurance reserves in total assets (rpr4) as a more direct indicator of reinsurance credit risk, is more relevant for the Serbian non-life insurance sector.

Finally, it is interesting that from the aspect of measuring capital adequacy to cover risks, the emphasis is on the insurers' assets (s2). Insurance risks, which are approximated by the premium, are generally considered to be the most important for non-life insurers. However, the obtained results show that in the case of the non-life

insurance sector in Serbia it is necessary to pay special attention to financial risks, arising from the assets side of the balance sheet of insurers.

Conclusion

Over the years, a large number of financial ratios have been developed and applied in the field of insurance. The calculation of all these ratios in the implementation of the financial analysis of insurance companies would be not only impractical, but also of little use, due to the interrelationships that exist between different ratios. In addition, not every ratio is equally suitable for every insurance market and in every period.

In this paper we applied principal component analysis in determining financial ratios that are representative within non-life insurance sector in Serbia. Starting from numerous financial ratios that are generally considered relevant for insurance companies, we identified a smaller number of ratios which can capture almost the same quantity of information available in the original larger set. Analysis has been applied over audited financial data of all 12 companies constituting non-life insurance sector in Serbia for the period 2010-2019. Initially 38 variables (financial ratios) were selected for the study and classified in seven categories.

Six ratios, operating expenses to gross premiums written, capital to total assets, real estate to total assets, reinsurance reserves to total assets, liquid assets to total assets and combined ratio were found to be representative for the sector. These ratios explain 85% of the total variability of all analyzed financial ratios.

The obtained results can serve as an input for further research based on financial indicators of non-life insurers. At the same time, the results can be useful for an efficient and purposeful analysis of the financial position and performance of individual insurance companies and the entire non-life insurance sector in Serbia. Thus, they can be valuable at the micro-level for business and investment decision making, as well as at the macro-level, in market surveillance and policymaking for the insurance sector.

The limitation of this research is certainly the small number of companies that participated in the analysis. However, since we limited the research to the example of the Republic of Serbia, the analysis included all companies in the non-life insurance sector. The time horizon for observing the financial ratios of the analyzed non-life insurance companies is the last available 10 years. The direction of future research would certainly, among other things, be to check the consistency of the obtained results on the basis of the latest collected data. Additionally, principal component analysis could be applied in determining financial ratios relevant for life insurance sector in Serbia.

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TESTING OF PORTFOLIO OPTIMIZATION THROUGH INVESTMENTS IN STOCK MARKET INDICES AND BITCOIN

Ispitivanje portfolio optimizacije ulaganjem u berzanske indekse i bitkoin

Abstract

This paper presents an empirical verification of the effectiveness and usefulness of investment diversification using the main stock exchange indices and Bitcoin. The objective is to determine the effects applying the Markowitz portfolio optimization theory, i.e., the advantages of applying the modern portfolio theory for institutional investors. The research offers an answer to the following question: what are the advantages and disadvantages of using Bitcoin in portfolio optimization? The paper contributes to the representation of the reach and limitations of the modern portfolio theory for institutional investors. The conclusion is that rational behaviour of institutional investors requires consideration of portfolio optimization using the Markowitz model, because it is possible to create portfolios which, on the basis of historical returns, provide desired returns alongside certain risks. The methodology includes the analysis of high frequency data, i.e., daily trading data were used. The results indicate that the use of the Markowitz portfolio selection method, with all its limitations, is desirable, possible and applicable, but that it entails serious flaws in the sense of neglecting transaction costs, foreign exchange differences and the real value in the stock market. The results of the research show that Bitcoin is a good source of diversification in a portfolio that contains traditional financial instruments both for the risk-averse investor as well as for those investors who have a greater appetite for risk. The conclusion is that rational behavior of institutional investors requires consideration of investing in Bitcoin using the Markowitz model. However, given the high degree of volatility, investors should be very careful when making decisions about including Bitcoin in the portfolio.

Keywords: *portfolio diversification, portfolio optimization, Bitcoin, optimal portfolio, risk, return.*

Sažetak

Rad se bavi empirijskom provjerom djelotvornosti i korisnosti diverzifikacije ulaganja koristeći glavne berzanske indekse i bitkoin. Cilj istraživanja je da se utvrde efekti primjene Markoviceve portfolio diverzifikacije odnosno optimizacije portfolija, tj. koristi od primjene moderne portfolio teorije za institucionalne investitore. Istraživanje će ponuditi odgovor na pitanje: „Koje su prednosti i nedostaci korištenja bitkoina u optimizaciji portfolija?" Doprinos rada ogleda se kroz predstavljanje dometa i ograničenja moderne portfolio teorije za institucionalne investitore. Zaključak je da racionalno ponašanje institucionalnih investitora nalaže razmatranje optimizacije portfolija upotrebom Markovicevog modela, jer je moguće kreirati portfolije koji na bazi istorijskih prinosa daju željene prinose uz određene rizik. Metodologija podrazumjeva analizu podataka visoke frekvencije, odnosno korišteni su dnevni podaci o trgovanju. Međutim, rezultati primjene značajno odstupaju od očekivanog prinosa. Rezultati pokazuju da je upotreba Markovicevog metoda portfolio selekcije, uz sva ograničenja, poželjna, moguća i primjenljiva, ali da ona ima ozbiljna ograničenja u smislu zanemarivanja transakcionih troškova, kursnih razlika i stvarne trgovine na berzi. Rezultati pokazuju da bitkoin predstavlja dobar izvor diverzifikacije u portfoliju koji sadrži tradicionalne finansijske instrumente kako za investitora koji nije sklon riziku, tako i za one investitore koji imaju veći apetit za rizik. Zaključak je da racionalno ponašanje institucionalnih investitora nalaže razmatranje ulaganja u bitkoin upotrebom Markovicevog modela. Ipak, uzimajući u obzir visoki stepen volatilnosti, investitori treba da budu veoma pažljivi kada donose odluke o uključivanju bitkoina u portfolio.

Ključne reči: *diverzifikacija portfolija, optimizacija portfolija, bitkoin, optimalan portfolio, rizik, povrat.*

Introduction

The possibilities of diversification have always been interesting for investors since diversification diminishes risk exposure and protects investors. Diversification potential enables investors to manage their risk and diminish exposure to risk. A good diversification policy represents a safety net which enables the reduction of investors' risk exposure and prevents a decrease in portfolio value. A well-diversified portfolio more often than not consists of different asset categories with low correlation, whereas highly correlated markets are characterized by a low diversification possibility. The greatest mystery in the sphere of investments is finding the optimal portfolio using available assets. There are a number of studies and mathematical models concerned with portfolio investment strategies. The contemporary portfolio theory aims at finding the optimal model with the best results.

During the years, financial markets have undergone immense changes. One of them is surmounting the obstacles for foreign portfolio flows shifting from one market to another [1] and the emergence of cryptocurrencies as financial assets. This paper will attempt to combine the classic modern portfolio theory with the concept of investing in cryptocurrency with the aim of achieving higher returns with a lower risk exposure.

The research question is: what are the advantages and disadvantages of using Bitcoin in portfolio optimization? The main research hypothesis is that geographical portfolio diversification for institutional investors, alongside all limitations of foreign markets and investors' placements, is desirable, possible and applicable. The supplementary hypothesis is the following: by combining investments in stock market indices and Bitcoin, it is possible to create a portfolio which rejects larger returns and lower risk in relation to a portfolio gained using the same securities but without investing in Bitcoin.

With the aim of testing the hypothesis proposed in this paper, the emphasis was put on the modern portfolio theory. The basic model was developed by Harry Markowitz in 1952 in his paper *Portfolio Selection* (Markowitz, 1952). The most significant contribution of the modern portfolio theory is the formula for the calculation of portfolio variance, i.e., for the calculation of an efficient portfolio diversification. Markowitz's most important assumption regarding investors' behavior within the model is that investors estimate portfolio risk on the basis of the variability of expected returns. Another assumption is that decisions on investments made by investors are mostly based on expected returns and risk. Hence, their utility curves are a function of the expected return and expected variance (or standard deviation) of the return. Also, an important hypothesis is that investors always prefer the highest returns for a certain risk level, i.e., the lowest risk for the same return level.

Financially speaking, a portfolio represents a combination of different asset types, i.e., financial instruments and deposits. Financial assets comprise any form of property with a value which can be exchanged. This can include securities, money in giro accounts, assets in foreign currency, gold and noble metals, cryptocurrency, etc. Two basic motives for portfolio creation are financial gain and risk diversification for the investor. The choice of an appropriate portfolio depends on the expected return rate, the risk of certain securities, correlation (the connection between returns) of certain securities, as well as investors' preferences (a tendency for or aversion to risk). The concept of diversification with the aim to diminish risk is most vividly reflected in the saying "Don't put all your eggs in one basket." When it comes to creating a securities portfolio in the financial market, it takes a lot more analysis and effort than a simple random choice of different securities.

In order to prove the hypothesis, we will observe a fictional investment fund which has two strategies: investing in developed countries and investing in emerging economies. Besides that, we will illustrate the effects of investments for all strategies without limitations in a single position, investments with limitations and investments with the combination of observed assets and Bitcoin.

Literature review

While classic portfolio theory performed diversification in order to diminish risk, the modern theory introduces a measurement of returns and risk, based on which

it corrects returns on the basis of risk and creates an efficient portfolio. Consequently, the modern theory represents a mathematical and statistical formulation of the diversification concept [2]. The development of investment diversification coincided with the development of portfolio theory [3]. The Markowitz portfolio selection model includes the identification of available risk-return combinations from a set of risky assets, construction of the optimal portfolio of risky assets and, then, the selection of the complete portfolio by combining risk-free assets and optimal risky portfolio [4].

Diversification aims at choosing a number of financial instruments which, observed as a portfolio, have a risk which is lower than the weighted risk average of securities included therein, if returns on securities included in the portfolio do not have a perfect positive correlation. This is possible because returns on financial instruments often take different directions, especially in periods of crisis. Besides, shares from specific sectors can also have a negative correlation, meaning that their prices take opposite directions and all of this therefore provides the opportunity to diminish risk when these securities are found in the portfolio.

The basic motive behind the interest of institutional investors is placement diversification, professional management and the simplicity of capital investments [5]. As financial intermediaries, institutional investors represent competition for traditional banks in the financial market. Institutional investors are specialised financial institutions which gather, or synthesize, small investors' savings by investing it in different investment forms in accordance with defined goals, such as acceptable risk, return maximization and claim maturity [6]. By looking at a wider context, the significance of institutional investors is reflected in raising the efficiency of the financial system [7]. They ensure better investment possibilities and more efficient channels for the allocation of economic resources "both through space and through time" [8]. In relation to that, institutional investors contribute to a larger supply in the market and facilitate the collection of capital for companies listed in the stock market. As a result, capital is cheaper, as well as services, which affects the decrease in fees and other expenses regarding trade and the procurement of capital in the market. Hence, they enrich the structure of the financial sector, i.e., deepen the capital market. At the same time, institutional investors largely contribute to the increase in savings by collecting smaller amounts of capital from individual owners, as well as to the rationalization of the use of capital by placing it in securities [9]. Three types of financial institutions are specifically prominent: pension funds, insurance companies and investment funds. Institutional investors have contributed to the elaboration of investment options for individual investors, competition strenthening in the market and to the balancing of bank-centered financial systems [7].

The term 'emerging market' includes countries characterized by institutional turbulence and a low level of economic development in relation to developed countries. In accordance with this, an emerging market may represent a country, or a market, in which there is an ongoing transition of the political or economic system and in which the economic development is higher than a one-digit percentage at the annual level [10]. Sixty-four emerging economic systems have been identified [11].

The most important advantage of the portfolio theory in relation to the classic theory is that it analyzes individual securities using correlation. Correlation, or the degree of connection between individual securities, is one of the key factors determining the success of a portfolio [12]. On the other hand, a detailed analysis of the portfolio theory and its proposition in every capital market points to the fact that it significantly simplifies the complex world of trading in securities. The first problem, often neglected in a large number of economic models, is ignoring transaction costs. Besides these costs, institutional restrictions on trading are also ignored. The extent to which this assumption limits the practical validity of the theory depends on the impact of transaction costs and institutional limitations on the manner of portfolio creation and trading [13].

Since the emergence of the modern portfolio theory, numerous authors have in different ways attempted to suggest to investors ways to properly choose initial sets of shares to be efficiently diversified in the portfolio. Considering specific conditions in small capital markets, what was set as the primary criterion for the selection of

shares when creating a portfolio is liquidity. The critique boils down to the fact that these costs are insignificant in the course of the initial portfolio creation, but they are important in cases when the portfolio needs to be adapted to the results obtained by applying the Markowitz model.

In accordance with the classic theory of economics, it is assumed that investors mostly aim at maximizing profit. Besides that, it is possible to reassess the assumption of the portfolio theory that all investors have the same information. Namely, it is widely accepted that there are differences in information, i.e., that one contracting party has more information than the other. What emerges here are problems with negative selection and moral hazard. Small investors struggle with obtaining information. On the other hand, this information asymmetry may be reduced by means of intermediaries, such as brokers, who own more information than individual investors. Nonetheless, it is clear that their level of awareness also differs. Namely, brokers' level of awareness depends on the possibility of obtaining additional information from issuers, as well as on the knowledge and skills for the interpretation of information available to the public, for example the impact of macroeconomic indicators or changes in regulations. Modeling results depend on the data to be used for a longer or shorter historical period or to be incorporated in future expectations. Depending on the data used in the model, each investor may have different data, which also leads to different investment decisions. A consequence of the assumption about knowing the same information would be that all investors create the same portfolio, i.e., that possible portfolio combinations are reduced as much as possible. The reason for this is that, according to the theory, all investors have access to the same information which contain the return rates of all securities in the past [13], [9].

Portfolio theory hypothesizes that stock exchange rates are arranged according to normal distribution. However, in reality, stock exchange rates have a large standard deviation which could not be foreseen by normal distribution. Classic economists have the tendency to eliminate all maximum deviations as an anomaly in order to obtain normal data distribution for their analyses. Still, an appropriate analysis needs to include all periods with extreme changes in prices since neglecting such periods would lead to a normal distribution which does not contain significant information. In relation to this, if stock exchange rates varied in accordance with the normal distribution, the stock market breakdown in 1987 with more than twenty standard deviations would have had a probability of one to a billion [14]. Also, an external shock, such as the 2020 pandemic, was almost impossible to consider during 2019.

The possibility of creating a portfolio using domestic securities through the imitation of foreign indices in order to achieve higher returns with no direct foreign exposure was examined [15]. They have determined that investments in foreign markets result in significant diversification advantages.

In 2003, Li, Sarkar and Wang [16] identified significant benefits for international diversification for an investor, headquartered in the US, despite portfolio limitations, especially when it comes to short-term trading, i.e., the sale of securities not yet owned by the investor. On the other hand, in 2004, Kearney and Lucey [17] emphasized reduced diversification benefits in emerging markets as correlations increase over time [18], [19]. Many authors have confirmed these conclusions [20], [21], [22].

At the same time, Berger, Pukthuanthong and Yang [23] showed in 2009 that a correlation between different markets does not have to necessarily indicate the level of integration of the observed markets. Furthermore, Berger et al. [23] use a variance analysis in order to point to benefits arising from international diversification, especially when there are investments in emerging markets. Alongside observing benefits of international investments per se, subsequent papers were also concerned with nuancing international diversification based on style. Estrada [24] examines the advantages of international diversification when applying fundamental indexation and identifies significant benefits for index diversification based on foundations using countries' index funds. Similarly, Eun, Huang and Lai [25] consider international portfolio diversification between 1980 and 1999 by using precisely variance tests. In order to deal with this issue, Fan [10] observes the benefits of international diversification using a sample of indices of large and small capital of G7

countries. The empirical findings of our study suggest that, during the whole period, investors will benefit from diversification through a combination of investments in companies from developed and emerging economies [26]. Li et al. [16] have synthesized research in this area and claimed that when ex post data are observed, there is huge potential for international diversification. On the other hand, the results for ex ante data are questionable due to correlation changes over time. In their paper, they also cite authors who had researched the significance and faster growth of emerging markets and diversification possibilities in these markets [28], [29], [30], [31], [32], [33].

Cryptocurrencies have nowadays penetrated the flows of real economies, and this phenomenon is a point of interest for economists, jurists, IT experts, hackers, central banks and security agencies. One of the reasons for the initial interest of technology and internet supporters and investors is the fact that cryptocurrencies are not subject to control by central banks or government agencies, their value being determined by a multitude of computers. Namely, these are protected from inflation through a mathematical function which makes it impossible for their quantity to exceed a limit determined in advance. A second feature of cryptocurrencies, seen as an advantage, reflects in eliminating intermediaries, which makes transactions cheaper – especially in international payments. What is emphasized as a benefit of cryptocurrencies is the fact that they are based on a decentralized system without the existence of a regulatory authority. On the other hand, it is precisely decentralization, user anonymity and the lack of a regulatory agency what is indicated as the main disadvantage [34]. Using the multivariate dynamic conditional correlation (DCC) model, Chuen, Guo and Wang [35] examined whether the inclusion of ten cryptocurrencies in a traditional portfolio of nine assets would bring additional benefits on risk-adjusted returns. Their findings suggest that the inclusion of the cryptocurrency index provides large improvements in the overall portfolio performance based on mean-variance, which was confirmed by the spanning test employed. Similarly, Ehlers and Gauer [36] employed the Kolmogorov–Smirnov test and variance ratio test (VRT) with heteroscedasticity adjustment to understand the role of five leading cryptocurrencies such as Bitcoin, Ethereum, Ripple, Litecoin, and Dash in a portfolio. They unearthed interesting findings that only Bitcoin and Ripple were shown to provide minimum variance portfolio benefits and volatility exposure, in line with Harry Markowitz's idea on the mean-variance portfolio. Briere, Oosterlinck and Szafarz [37] used weekly data over the period from 2010-2013, and they analyzed a Bitcoin investment from the standpoint of a U.S. investor with a diversified portfolio including both traditional assets (worldwide stocks, bonds, hard currencies) and alternative investments (commodities, hedge funds, real estate). They concluded that, during the observed period, Bitcoin investment had highly distinctive features, including the exceptionally high average return and volatility. Also, they concluded that Bitcoin investments offer significant diversification benefits. Carpenter [38] used a modifiied mean-variance framework and showed that Bitcoin can be a viable diversification tool. His research showed that Bitcoin investment could be skewed by return activity that occurred during a speculative bubble in 2013 [39]. The stated conclusions are in line with Grujić's [22] recommendation that it is rational for financial intermediaries in developing countries to change their business models and adapt them to the accelerated market changes [40].

It may be said that the use of cryptocurrencies in the sense of an alternative to classic money is greatly limited for two reasons. Firstly, although the amount of cryptocurrencties is limited, every individual or group may create, agree on the name of a currency and rules, and use a multitude of other cryptocurrencies. There are already more than a thousand cryptocurrencies. Secondly, despite the limited supply, the price of cryptocurrencies depends on the supply and demand. Supporters of the use of cryptocurrencies point to the limitation in cryptocurrency supply. Namely, in classic currencies the supply is limited by the amount of money as prescribed by central banks. Therefore, on the one hand there is a 'quasi-limitation' of supply, and on the other hand, there is some variability in demand, which points to a significant instability of the central bank. Bitcoin can be split up to the amount of 0.00000001 Bitcoin, i.e., up to a Satoshi. The smallest unit was named Satoshi, after the author (or several authors) of

the original document in which it was initially mentioned [41]. The system enables an unlimited number of everyday transactions but, as the time passes, Bitcoin will also be lost in everyday trading. The nonexistence of a regulatory system and anonymity render Bitcoin suitable for the financing of criminal activities, from money laundering and financing of crime to drug and weapons trafficking and terrorism. Hence, transactions in virtual currencies are public and largely impossible to trace. In this way, a high level of anonymity is ensured for virtual currency users. Precisely such malpractice may affect the closing of the currency trading platform and disabling of access or the use of assets in certain platforms or stock markets. Large changes and constant price growth represented an attractive instrument both for professional investors and for complete amateurs when it comes to investing. At the same time, it was specifically high variability what led professional investors to be careful regarding long-term investments in cryptocurrencies. Unlike other currencies, cryptocurrencies are not supported by the rule of law, but by technology. Transfer is simple, there are no intermediaries and a third party may not prevent or change transactions. Assuming that all legal systems broke down, cryptocurrencies would continue to exist with the existence of the Internet and people ready to use them. Other important features of cryptocurrencies are that ownership is secured by strong cryptography, transactions are visible but the users are anonymous, the person sending cryptocurrencies, as opposed to the receiver, must be connected to the internet and nothing guarantees its value besides the supply and demand.

Methodology

The modern portfolio theory uses basic statistical categories, such as: variance, standard deviation, correlation and covariance, and categories such as beta and other derived indicators, in order to set up and measure the connection between return and risk in the portfolio. The basic difference between the classic portfolio theory (which dealt with the diversification of different types of assets by combining their different rates of risk and return and performed individual selection of securities on the basis of the analysis of individual shares) and the modern portfolio theory lies in the fact that the contemporary portfolio theory introduces a mathematical and statistical analysis when choosing a portfolio with the aim of creating an optimal portfolio. The Markowitz model is based on several assumptions which are related to investors' behaviour. The most important among these rely on the maximum expected return on the portfolio with a risk level acceptable for them, or alternatively, the reduction of risk to which they are to be exposed alongside a certain assumed level of the expected return on the portfolio.

According to this theory, larger return does not necessarily have to entail higher risk.

The assumptions within the portfolio theory advocated by Markowitz are the following:

- investors consider any investment alternative represented by the distribution of the probability of expected returns in the observed period;
- investors assess portfolio risk on the basis of the variability of the expected portfolio returns;
- investors' decisions are only based on the expected return and risk, their utility curves therefore being a function of the expected returns and the expected variance (or standard deviation) of returns;
- investors maximize the expected utility and their utility curves demonstrate the diminishing marginal wealth utility;
- for a given risk level, investors prefer higher returns as opposed to lower ones and vice versa. For a given level of expected returns, investors prefer lower risk to higher risk.

This paper treats indices as separate securities. In reality, exchange-traded funds replicating the changes in indices are the closest equivalent to that. In order to determine the risk of individual positions being invested in, what is necessary is the standard deviation, or variance, since it measures the extent to which specific amounts, in this case returns, are far from the average. A variance is defined as a square deviation from the average, as indicated by the following calculation pattern:

$$\sigma^2 = \sum_{i=1}^{n} [R_i - E(R_i)]^2 P_i$$

Squaring is advantageous since positive and negative deviations are not mutually effaced. However, squaring leads to large numbers difficult to interpret precisely, therefore resulting in the recommendation to use the variance root, the so-called standard deviation:

$$\sigma = \sqrt{P_i[R_i - E(R_i)]^2}$$

We can see that the correlation between the securities returns, for example A and B, may be expressed through the following pattern:

$$(p_A, p_B) = \frac{\Sigma_{i=1}^{n}(p_A - \mu_A)(p_B - \mu_B)}{\sqrt{\Sigma_{i=1}^{n}(p_A - \mu_A)^2 * \Sigma_{i=1}^{n}(p_B - \mu_B)^2)}}$$

However, for our analysis it is necessary to note the manner in which standard deviation is observed in the portfolio. Because of that, the correlation coefficient needs to be merged with the standard deviation of shares in the portfolio. This yields the so-called covariance calculated using the following pattern:

$$cov_{AB} = \sigma_A \, \sigma_B \, \rho_{AB}$$

After defining the share of individual securities in the portfolio, the average return and standard deviation of the portfolio return may be calculated. When calculating the average portfolio return, we simply calculate the weighted average of individual securities' returns [2], p 81).

The expected portfolio return depends on the share of securities in the portfolio. The total portfolio return will be between the return on a security with the lowest expected return and the return on a security with the highest expected return (Markowitz, 1952, pp. 83-84).

The variance of a portfolio with N securities is calculated using the following pattern:

$$Var\,(p) = \sum_{i=1}^{N} \sum_{j=1}^{N} x_i x_j \sigma_{ij}$$

This formula is one of the greatest values of portfolio theory. It proves that portfolio risk depends on the securities correlation, or a certain type of property. The contribution of this formula amounts to the suggestion that, when creating a portfolio, what should be analyzed is the extent to which returns on specific asset types are connected. If the correlation exceeds 1, in this case the data have the identical development; on the other hand, if the correlation amounts to -1, the data entail the opposite development (for instance, an increase in the price of instrument A leads to a decrease in the price of instrument B), while a correlation amounting to 0 means that data develop in completely different ways.

Combining securities in the portfolio, if they do not express a perfect positive correlation, affects the reduction of portfolio risk. Therefore, portfolio diversification is a result of combining securities, investments with returns which do not have a perfect positive correlation. Examples of diversified portfolios closely adhere to market returns. In case we invest in a single security, the portfolio risk, incorporated in this single security, then equals its standard deviation. If the number of randomly chosen shares in the portfolio is increased, the total portfolio risk is reduced and this reduction occurs at a declining rate. Briefly, portfolio diversification represents the result of combining assets being invested in, i.e., all securities and other investments with returns which do not have a perfectly positive correlation. Portfolio risk depends on the correlation between returns on the assets in the portfolio.

When creating a risky portfolio, consisting of two types of risky assets, what is most important is the connection between changes in returns on assets. Portfolio risk depends on the correlation between returns on assets in the portfolio. Unsystematic risk more and more slowly approaches zero when new chosen securities are added into the portfolio. As the number of chosen securities to be included in the portfolio increases, the total risk diminishes, but there is still the undiminished part with the increase in the number of securities in the portfolio.

In accordance with the noted subject of analysis, what was observed are the indices of the world's most famous stock exchanges during 2019. Specifically, not all securities quoted in the observed markets were included in the analysis. Such a simplification of the analysis concurs with the remark of a large number of authors that, by including securities above a larger number in the portfolio, the diversification effect is reduced. For each index we have calculated expected returns at the annual level and the matrix of variance and covariance, also at the annual level, with other securities in the portfolio.

The following limitations were set:

- the sum of the percentage share of securities in the portfolio needs to be over 100%,
- the amount of certain securities in the portfolio must not be negative, i.e., we have disregarded the so-called short-term sale and
- a separate calculation is made for each demanded return.

On the basis of the variance-covariance matrix, i.e., on the basis of expected returns and risk of shares, we have determined the shares of securities in the portfolio for which the demanded return will be achieved with the lowest possible risk, or with the lowest portfolio variance.[1]

$$\sigma_P^2 = w^T * \sum w$$

The following pattern is obtained after elaborating this equation:

$$\sigma_P^2 = [w_1\, w_2 \ldots w_i \ldots w_n] \begin{bmatrix} \sigma_{11}\, \sigma_{12} \ldots \sigma_{1j} \ldots \sigma_{1n} \\ \sigma_{21}\, \sigma_{22} \ldots \sigma_{2j} \ldots \sigma_{2n} \\ \ldots \ldots \ldots \ldots \ldots \ldots \\ \sigma_{i1}\, \sigma_{i2} \ldots \sigma_{ij} \ldots \sigma_{in} \\ \ldots \ldots \ldots \ldots \ldots \ldots \\ \sigma_{n1}\, \sigma_{n2} \ldots \sigma_{nj} \ldots \sigma_{nn} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ \ldots \\ w_i \\ \ldots \\ w_n \end{bmatrix}$$

The expected return on the obtained MEF curve (*Markowitz efficient frontier*) varies from the largest expected return on a share (if we invested 100% of the amount only in a security with the largest share) to the lowest expected return on a share (if we invested 100% of the amount only in a share yielding the lowest return).

1 With the aim of a faster and more accurate calculation, portfolio optimization was derived using the Solver subprogram. This is a free add-in of the Microsoft Excel program package.

Empirical data and analysis

The data were collected from the stock exchanges of the observed countries. The countries were divided according to the criterion used by Hoskisson, Eden, Lau and Wright [11] for developed and emerging economies and they are presented in Table 1.

Variance-covariance matrices were created for both combinations (Table 4, Table 5).

Results and discussion

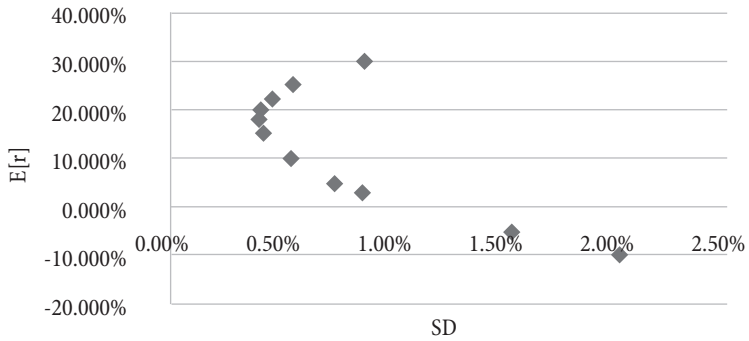
The obtained results adhere to conclusions provided by Li et al. (2003), Kearney and Lucey (2004), Switzer and Tahaoglu (2015), Fan (2008), Estrada (2008), Eun et al. (2008), Berger et al. (2013). The paper proves that the use of the Markowitz method of portfolio selection in the shares in emerging markets is, with all its limitations, possible, i.e., it is desirable and applicable.

By applying the diversification model, or portfolio optimization, different investment combinations were obtained. An investor has the possiblity to optimize the portfolio by investing only in developed economies (Figure 1) or only in emerging economies (Figure 2).

Similarly, by applying the described diversification model, i.e., portfolio optimization, the investor has the possibility to optimize the portfolio by also considering changes in the value of Bitcoin (Figure 3) or only in emerging economies (Figure 2).

If we observe the results obtained for expected returns of 5%, 10%, 15%, 20%, 25% and 30%, we can observe that, according to the model, by aiming for the

Figure 1: The Markowitz efficient frontier for developed economies



Source: Authors' calculations.

Table 1: Presentation of observed countries and analyzed indices

Number	Country	Index	Emerging economy	2020	2019	2018
1	United States	DJIA	No	30,409.56	28,538.44	23,327.46
3	Japan	Nikkei 225	No	26,854.03	23,656.62	20,014.77
4	Germany	DAX 30	No	13,718.78	13,249.01	10,558.96
5	France	CAC 40	No	5,599.41	5,978.06	4,730.69
6	United Kingdom	GSPTSE	No	17,545.81	17,063.43	14,322.86
8	Italy	FTSEI40	No	2,165.00	2,289.40	1,782.00
10	Canada	GSPTSE	No	17,545.81	17,063.43	14,322.86
11	Australia	AXJO	No	6,587.10	6,684.10	5,646.40
12	Spain	IBEX35	no	8,154.40	9,549.20	8,539.90
17	Netherlands	AEX	no	628.06	604.58	487.88
18	Switzerland	SMI	no	10,703.51	10,616.94	8,429.30
19	Sweden	OMXS30	no	1,874.74	1,771.85	1,408.74
20	Norway	OSE	no	973.97	931.45	799.46
21	Belgium	BFX	no	3,663.06	3,955.83	3,243.63
22	Austria	ATX	no	2,780.44	3,186.94	2,745.78
25	Denmark	OMXC20	no	1,465.17	1,135.79	1,135.79
28	Finland	OMXHPI	no	27,147.11	28,189.75	25,845.70
29	Greece	ATG	no	10,872.05	9,874.66	8,709.58
31	Portugal	PSI20	no	1,567.46	1,616.70	1,333.18
32	Ireland	ISEQ 20	no	4,921.78	5,214.14	4,731.47
33	New Zealand	NZX 50	no	1,318.32	1,196.30	909.82
2	China	SSEC	yes	3,414.45	3,050.12	2,493.90
7	Brazil	BVSP	yes	119,017.24	115,645.34	87,887.26
9	India	BSESN	yes	47,746.22	41,253.74	36,068.33
13	Mexico	S&P_BMV IPC	yes	44,693.96	43,541.02	41,640.27
14	South Korea	KOSPI	yes	2,873.47	2,197.67	2,041.04
15	Indonesia	JKSE	yes	5,979.07	6,299.54	6,194.50
16	Turkey	BIST100	yes	1,479.91	1,144.25	912.70
23	South Africa	SAT40	yes	54,615.33	50,816.05	46,726.59
24	Thailand	SETI	yes	1,449.35	1,579.84	1,563.88
26	Chile	SPIPSA	yes	327.43	372.16	342.92
27	Hong Kong	HSI	yes	4,177.22	4,669.85	5,105.43
30	Israel	TA125	yes	1,567.46	1,616.70	1,333.18
34	Croatia	CROBEX10	yes	1,739.29	2,017.43	1,748.81
35	Slovenia	SBITOP	yes	900.85	925.86	804.26
36	Serbia	BELEX15	yes	746.57	801.69	761.69
37	Bosnia and Herzegovina	BIRS	yes	576.94	618.31	565.48
38	Bosnia and Herzegovina	SASX30	yes	1,428.43	1,288.46	1,135.79
39	Bitcoin	BTC	no	28,840.95	7,193.60	3,742.70

Source: Authors' calculations.

Table 2: Illustration of expected returns for developed countries in 2019 and returns achieved in 2020

Country	United States	Japan	Germany	France	United Kingdom	Italy	Canada	Spain	Netherlands	Switzerland	Sweden	Norway	Belgium	Austria	Finland	Greece	Portugal	Ireland	New Zealand
Expected return	22.24%	20.93%	25.22%	27.48%	18.93%	23.72%	18.93%	11.69%	24.25%	25.41%	26.03%	15.94%	23.08%	15.02%	12.21%	-15.42%	9.98%	31.25%	10.38%
Return achieved in 2020	6.02%	18.27%	2.49%	-8.11%	1.95%	12.57%	1.95%	-16.69%	1.92%	0.03%	3.66%	3.47%	-9.83%	-13.90%	8.49%	-13.08%	-6.98%	5.86%	13.52%

Source: Authors' calculations.

Table 3: Illustration of expected returns for emerging economies in 2019 and returns achieved in 2020

Country	China	Brazil	India	Mexico	South Korea	Indonesia	Turkey	Taiwan	Thailand	Singapore	Hong Kong	Israel	Croatia	Slovenia	Serbia	Bosnia and Herzegovina	Bosnia and Herzegovina
Expected return	23.72%	27.07%	14.94%	3.00%	9.34%	1.92%	28.76%	30.99%	0.89%	9.53%	12.17%	21.17%	16.66%	15.01%	9.55%	9.30%	13.44%
Return achieved in 2020	12.57%	0.37%	14.71%	-0.83%	32.10%	-4.85%	27.38%	27.28%	-9.18%	-13.59%	-4.60%	-3.90%	-14.29%	-3.24%	-6.21%	-6.76%	10.88%

Source: Authors' calculations.

Table 4: Variance-covariance matrix for developed countries

	United States	Japan	Germany	France	United Kingdom	Italy	Canada	Spain	Netherlands	Switzerland	Sweden	Norway	Belgium	Austria	Finland	Greece	Portugal	Ireland	New Zealand
United States	0.000061	0.000007	0.000047	0.000047	0.000026	0.000046	0.000026	0.000038	0.000041	0.000031	0.000043	0.000035	0.000042	0.000041	0.000039	-0.000006	0.000036	0.000043	0.000002
Japan	0.000007	0.000071	0.000014	0.000013	0.000006	0.000008	0.000006	0.000012	0.000016	0.000007	0.000020	0.000018	0.000021	0.000019	0.000015	-0.000026	0.000013	0.000019	-0.000002
Germany	0.000047	0.000014	0.000077	0.000066	0.000025	0.000065	0.000025	0.000058	0.000057	0.000043	0.000064	0.000048	0.000062	0.000057	0.000053	-0.000013	0.000048	0.000065	0.000004
France	0.000047	0.000013	0.000066	0.000070	0.000025	0.000063	0.000025	0.000054	0.000057	0.000044	0.000061	0.000047	0.000060	0.000052	0.000049	-0.000016	0.000045	0.000060	0.000004
United Kingdom	0.000026	0.000006	0.000025	0.000025	0.000021	0.000025	0.000021	0.000019	0.000022	0.000017	0.000023	0.000019	0.000023	0.000020	0.000020	0.000005	0.000019	0.000019	0.000001
Italy	0.000046	0.000008	0.000065	0.000063	0.000025	0.000085	0.000025	0.000057	0.000053	0.000041	0.000058	0.000048	0.000059	0.000056	0.000050	-0.000021	0.000048	0.000060	-0.000001
Canada	0.000026	0.000006	0.000025	0.000025	0.000021	0.000025	0.000021	0.000019	0.000022	0.000017	0.000023	0.000019	0.000023	0.000020	0.000020	0.000005	0.000019	0.000019	0.000001
Spain	0.000038	0.000012	0.000058	0.000054	0.000019	0.000057	0.000019	0.000061	0.000047	0.000035	0.000050	0.000040	0.000053	0.000047	0.000044	-0.000028	0.000042	0.000056	-0.000002
Netherlands	0.000041	0.000016	0.000057	0.000057	0.000022	0.000053	0.000022	0.000047	0.000055	0.000039	0.000052	0.000042	0.000053	0.000045	0.000042	-0.000015	0.000040	0.000052	0.000001
Switzerland	0.000031	0.000007	0.000043	0.000044	0.000017	0.000041	0.000017	0.000035	0.000039	0.000044	0.000038	0.000035	0.000039	0.000033	0.000033	-0.000012	0.000030	0.000039	0.000003
Sweden	0.000043	0.000020	0.000064	0.000061	0.000023	0.000058	0.000023	0.000050	0.000052	0.000038	0.000076	0.000050	0.000057	0.000055	0.000056	0.000003	0.000046	0.000057	0.000010
Norway	0.000035	0.000018	0.000048	0.000047	0.000019	0.000048	0.000019	0.000040	0.000042	0.000035	0.000050	0.000066	0.000044	0.000046	0.000044	0.000005	0.000037	0.000043	0.000009
Belgium	0.000042	0.000021	0.000062	0.000060	0.000023	0.000059	0.000023	0.000053	0.000053	0.000039	0.000057	0.000044	0.000071	0.000055	0.000051	-0.000018	0.000047	0.000061	0.000001
Austria	0.000041	0.000019	0.000057	0.000052	0.000020	0.000056	0.000020	0.000047	0.000045	0.000033	0.000055	0.000046	0.000055	0.000075	0.000053	-0.000020	0.000047	0.000059	0.000000
Finland	0.000039	0.000015	0.000053	0.000049	0.000020	0.000050	0.000020	0.000044	0.000042	0.000033	0.000056	0.000044	0.000051	0.000053	0.000067	-0.000011	0.000043	0.000052	0.000005
Greece	-0.000006	-0.000026	-0.000013	-0.000016	0.000005	-0.000021	0.000005	-0.000028	-0.000015	-0.000012	0.000003	0.000005	-0.000018	-0.000020	-0.000011	0.000661	-0.000011	-0.000039	0.000088
Portugal	0.000036	0.000013	0.000048	0.000045	0.000019	0.000048	0.000019	0.000042	0.000040	0.000030	0.000046	0.000037	0.000047	0.000047	0.000043	-0.000011	0.000058	0.000047	-0.000002
Ireland	0.000043	0.000019	0.000065	0.000060	0.000019	0.000060	0.000019	0.000056	0.000052	0.000039	0.000057	0.000043	0.000061	0.000059	0.000052	-0.000039	0.000047	0.000097	0.000000
New Zealand	0.000002	-0.000002	0.000004	0.000004	0.000001	-0.000001	0.000001	-0.000002	0.000001	0.000003	0.000010	0.000009	0.000001	0.000000	0.000005	0.000088	-0.000002	0.000000	0.000149

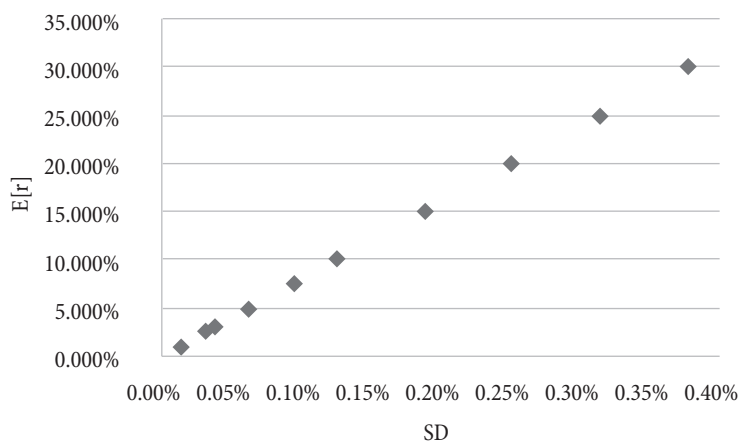
Source: Authors' calculations.

Table 5: Variance-covariance matrix for emerging economies

	China	Brazil	India	Mexico	South Korea	Indonesia	Turkey	Taiwan	Thailand	Singapore	Hong Kong	Israel	Croatia	Slovenia	Serbia	Bosnia and Herzegovina	Bosnia and Herzegovina
China	0.00012090	0.00000091	0.00001636	0.00000971	0.00003389	0.00001803	0.00001828	0.00003373	0.00001203	0.00003506	0.00001332	0.00001230	0.00000423	0.00000033	0.00000121	0.00000630	0.00000036
Brazil	0.00000091	0.00012373	0.00000113	0.00003325	0.00000840	0.00001043	0.00001897	0.00001401	0.00001076	0.00000712	0.00003037	0.00001188	-0.00000373	0.00000150	-0.00000312	-0.00000692	0.00000139
India	0.00001636	0.00000113	0.00007255	0.00001092	0.00001437	0.00001120	0.00001419	0.00000924	0.00000671	0.00000936	0.00000475	0.00000859	0.00000284	-0.00000366	0.00000655	0.00000092	0.00000094
Mexico	0.00000971	0.00003325	0.00001092	0.00006603	0.00001061	0.00000795	0.00001283	0.00002235	0.00000870	0.00000914	0.00002603	0.00000856	-0.00000097	0.00000071	0.00000308	-0.00000833	0.00000101
South Korea	0.00003389	0.00000840	0.00001437	0.00001061	0.00006045	0.00001786	0.00001361	0.00002678	0.00001463	0.00002712	0.00001700	0.00001094	0.00000273	0.00000185	-0.00000125	0.00000347	-0.00000026
Indonesia	0.00001803	0.00001043	0.00001120	0.00000795	0.00001786	0.00004695	0.00001107	0.00000846	0.00000804	0.00001506	0.00001530	0.00000259	0.00000208	0.00000074	0.00000120	0.00000886	-0.00000146
Turkey	0.00001828	0.00001897	0.00001419	0.00001283	0.00001361	0.00001107	0.00016442	0.00002061	0.00000909	0.00001796	0.00002785	0.00000710	0.00000023	0.00000816	0.00001350	-0.00000220	-0.00000401
Taiwan	0.00003373	0.00001401	0.00000924	0.00002235	0.00002678	0.00000846	0.00002061	0.00007269	0.00001317	0.00002268	0.00001947	0.00001691	0.00000369	0.00000152	-0.00000270	-0.00000021	0.00000046
Thailand	0.00001203	0.00001076	0.00000671	0.00000870	0.00001463	0.00000804	0.00000909	0.00001317	0.00003325	0.00001324	0.00001044	0.00000738	0.00000008	-0.00000049	0.00000340	-0.00000001	-0.00000051
Singapore	0.00003506	0.00000712	0.00000936	0.00000914	0.00002712	0.00001506	0.00001796	0.00002268	0.00001324	0.00004221	0.00001203	0.00001074	0.00000204	0.00000240	0.00000039	0.00000188	-0.00000085
Hong Kong	0.00001332	0.00003037	0.00000475	0.00002603	0.00001700	0.00001530	0.00002785	0.00001947	0.00001044	0.00001203	0.00010757	0.00001266	0.00000417	0.00000322	0.00000022	0.00000187	0.00000020
Israel	0.00001230	0.00001188	0.00000859	0.00000856	0.00001094	0.00000259	0.00000710	0.00001691	0.00000738	0.00001074	0.00001266	0.00003563	0.00000131	-0.00000044	0.00000478	0.00000177	-0.00000177
Croatia	0.00000423	-0.00000373	0.00000284	-0.00000097	0.00000273	0.00000208	0.00000023	0.00000369	0.00000008	0.00000204	0.00000417	0.00000131	0.00001905	0.00000174	-0.00000104	-0.00000156	-0.00000030
Slovenia	0.00000033	0.00000150	-0.00000366	0.00000071	0.00000185	0.00000074	0.00000816	0.00000152	-0.00000049	0.00000240	0.00000322	-0.00000044	0.00000174	0.00001838	0.00000228	0.00000179	-0.00000034
Serbia	0.00000121	-0.00000312	0.00000655	0.00000308	-0.00000125	0.00000120	0.00001350	-0.00000270	0.00000340	0.00000039	0.00000022	0.00000478	-0.00000104	0.00000228	0.00004686	-0.00000281	-0.00000125
Bosnia and Herzegovina	0.00000630	-0.00000692	0.00000092	-0.00000833	0.00000347	0.00000886	-0.00000220	-0.00000021	-0.00000001	0.00000188	0.00000187	0.00000177	-0.00000156	0.00000179	-0.00000281	0.00009693	-0.00000088
Bosnia and Herzegovina	0.00000036	0.00000139	0.00000094	0.00000101	-0.00000026	-0.00000146	-0.00000401	0.00000046	-0.00000051	-0.00000085	0.00000020	-0.00000177	-0.00000030	-0.00000034	-0.00000125	-0.00000088	0.00001428

Source: Authors' calculations.

Figure 2: The Markowitz efficient frontier for emerging economies

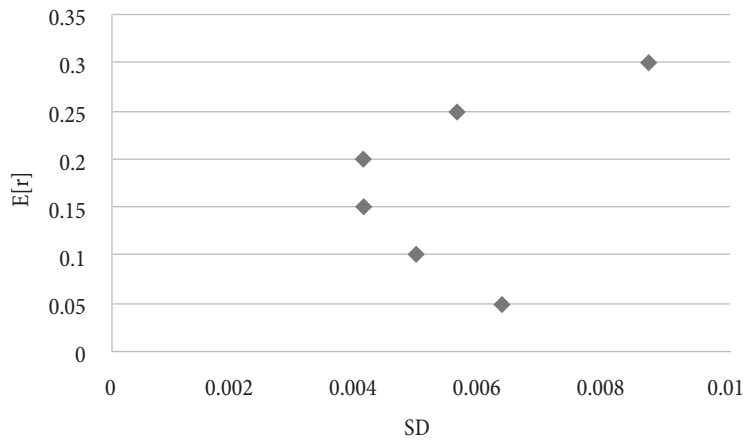


Source: Authors' calculations.

same returns, it is possible in emerging economies to achieve a lower standard deviation, i.e., the investor is exposed to lower risk. It is interesting that by introducing Bitcoin, standard deviation in developed economies is truly reduced to a specific desired return. On the other hand, combining Bitcoin and investment in shares in emerging markets barely differs from the creation of a portfolio with no Bitcoin. Still, investing in Bitcoin in 2020 would have proven to be a very wise decision. Portfolios obtained through diversification based on data for 2019 would successively yield lower returns in relation to those expected. However, if one also invests in Bitcoin, returns are significantly higher than expected (Table 6).

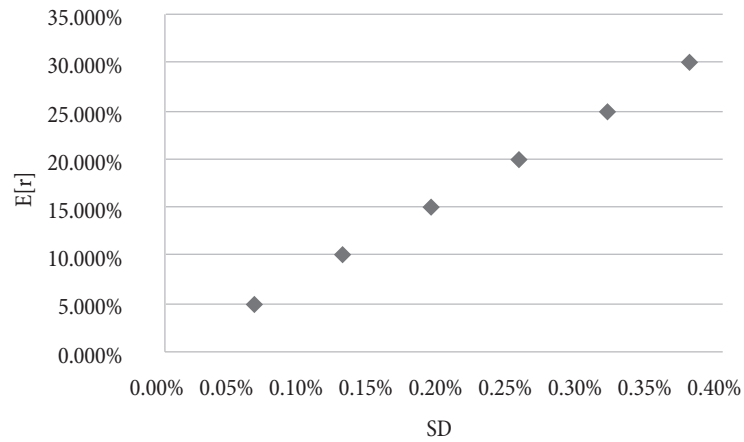
Using minor adjustments in the original formula, it is possible to adjust the variance value to the maximum, minimum or even precisely determined value. In other

Figure 3: The Markowitz efficient frontier for emerging economies in combination with BTC



Source: Authors' calculations.

Figure 4: The Markowitz efficient frontier for emerging economies



Source: Authors' calculations.

Table 6: Results of optimization in developed countries

Illustration	Standard deviation				Achieved returns in 2020			
Expected returns	Developed economies	Emerging economies	Developed economies with BTC	Emerging economies with BTC	Developed economies	Emerging economies	Developed economies with BTC	Emerging economies with BTC
5%	0.736%	0.063%	0.631%	0.063%	-8.21%	0.37%	15.02%	4.33%
10%	0.540%	0.126%	0.491%	0.127%	-3.12%	0.63%	33.40%	8.89%
15%	0.421%	0.188%	0.407%	0.190%	2.39%	0.94%	51.75%	14.64%
20%	0.406%	0.251%	0.406%	0.253%	5.34%	1.09%	60.60%	17.81%
25%	0.556%	0.314%	0.556%	0.317%	4.90%	1.41%	60.47%	22.55%
30%	0.868%	0.377%	0.868%	0.377%	4.62%	1.72%	4.62%	26.90%

Source: The authors' calculations.

words, it is possible to create different combinations of securities in the portfolio with different risk levels. Besides, it is also possible to adjust certain limitations of exposures towards a certain security, country or index. Furthermore, by setting limitations, both the highest possible gain and the lowest possible gain are diminished because the share of the security bearing extreme returns (negative or positive) is limited. This limitation also affects the variance, or standard deviation of the portfolio.

The portfolio theory, alongside the lack of assumption about the investors' rationality, is flawed in that it does not consider the individual function of an investor's utility and their individual attitude toward risk. Certainly, there are always investors who are ready to take over a higher risk. Another limitation of the modern portfolio theory is the fact that, when choosing the optimal portfolio, neither transaction costs nor foreign exchange differences are considered.

The biggest flaw of this approach is ignoring transaction costs and foreign exchange differences.

Conclusion

The paper assumes that all institutional investors in the Western Balkans have similar problems. In financial literature, a portfolio is often defined as a collection of two or more securities of different types and features (money market instruments, capital market instruments, financial derivatives, etc.) or other assets (gold and silver) owned by an investor in the financial market. Historically, the portfolio theory went through its two main stages: traditional or classic portfolio theory and the modern portfolio theory.

The current paper differentiates between achieved and expected returns. Achieved returns when investing in a security represent historical returns which show us how much we have earned in the past on account of owning a security, while expected income relates to the future and indicates investors' expectations, or how much an investor should earn in the future based on ownership of a security. Hence, expected returns on a portfolio represent the weighted average of all expected returns on financial instruments constituting the portfolio. The weighting factor is the share of all financial instruments in the portfolio, where the sum of all weighting factors always equals number one.

Unlike expected returns, risk (standard deviation) of a portfolio does not represent the weighted average of standard deviations of securities in the portfolio because in that case the connection between two securities would be neglected. The examination of the direction of changes of two securities is determined by calculating covariance. Through the standardization of covariance, we obtain a correlation coefficient which represents a statistical model indicating the direction in which two securities change and the strength of connection between them.

The paper examines the reach and limitations of the application of portfolio theory in portfolio diversification for institutional investors in emerging financial markets, whereby the research results are encouraging. By using the Markowitz portfolio selection method, the effect of diversification in the observed markets was shown. The results indicate that the use of the Markowitz portfolio selection method with securities in emerging markets is, with all its limitations, desirable, possible and applicable, which proves the accuracy of the hypothesis set in introductory remarks.

However, the obtained results prove that portfolio risk is not significantly reduced through diversification, i.e., the sum of systematic market risk and unsystematic specific risk, since an investor is in certain cases significantly exposed to the risk of a single security.

Despite its revolutionary success in the theoretical domain, the portfolio optimization model in reality demands certain improvements in order for results to be applicable in real investments. A detailed analysis of the modern portfolio theory and its propositions in each capital market indicates that this theory significantly simplifies trading in securities. One of the biggest problems is ignoring transaction costs. Also, this theory assumes that all investors are rational and that they mostly aim at maximizing profit. Besides, it is possible to question the proposition that all investors have the same information. When considering all the limitations, diversification results will also depend on the set of data used for the creation

of the model – whether a longer or shorter series of data will be used or future expectations will be incorporated into modeling.

Emerging capital markets are characterized by extremely low level of share liquidity, which creates an illusion of a negative correlation, further leading to the creation of suboptimal portfolios. Therefore, share liquidity should be the primary criterion for the selection of shares in the portfolio.

One of the most significant critiques also found in connection with the modern portfolio theory is that in financial crises, correlation coefficients converge toward one, whereby diversification advantages disappear and portfolio risk equals the simple weighted sum of the risk of individual securities in the portfolio. Even in developed markets such as the one in New York, in situations of significant financial shocks, there may be some relatively sudden changes in correlation coefficients. Still, the most important recommendation for the creation of portfolio in emerging economies results from the fact that securities liquidity is relatively low in such markets.

What should be considered regarding capital markets in developing countries characterized by low liquidity is a low free float, i.e., a small percentage of shares is freely traded. This means that the investors, when they want to sell the shares they own, might not be able to do so due to a lack of demand in the market. Hence, the modern portfolio theory and diversification are not to be dismissed or understood as the only or the best way of managing risk.

Further research may be concerned with testing models in different time periods. For instance, data from three years ago could be tested within the last year. For example, a certain virtual portfolio might be created on the basis of data from 2014 to 2017 and the obtained portfolio may be tested against data from 2017 until today. Additionally, future research might be directed toward introducing different models of transaction costs and the analysis of the impact of different criteria on the choice of shares in the portfolio, as well as the different length of the time series on the basis of which estimates are obtained. Also, subsequent research might deal with the advancement of optimization in such a way as to introduce the maximum number of transactions and costs for the optimization of portfolio in developing markets, which will simplify decision-making regarding later trading for institutional investors. Finally, research may be directed toward the comparison of the main indices in regional stock markets with the aim to explore whether there is a statistically significant correlation between returns on different indices.

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EU MONETARY AND FISCAL POLICY RESPONSES TO THE COVID-19 CRISIS

Odgovori monetarne i fiskalne politike u EU na krizu izazvanu kovidom 19

Abstract

The COVID-19, or, the coronavirus crisis represents an unprecedented global threat in recent history that, as symmetric external shock, affects social and economic dynamics of different countries and regions on both macro and micro levels. The aim of the paper is to provide a critical overview of economic policy responses to the ongoing crisis in the EU and, in particular, the eurozone. The paper tends to answer the question whether proposed monetary and fiscal actions provide feasible risk mitigating tools for the ongoing crisis or are there some viable policy actions that are omitted?

Keywords: *COVID-19, monetary and fiscal responses, eurozone.*

Sažetak

Kriza izazvana kovidom 19 ili koronavirusom predstavlja globalnu pretnju bez presedana u skorijoj istoriji koja, kao simetričan eksterni šok, utiče na društvenu i ekonomsku dinamiku različitih zemalja i regiona kako na makro, tako i na mikro nivou. Cilj ovoga rada jeste da pruži kritički osvrt na odgovore ekonomske politike na tekuću krizu u EU i, posebno, u evrozoni. U radu se teži odgovoriti na pitanje da li predložene monetarne i fiskalne aktivnosti pružaju adekvatan instrumentarijum za smanjenje rizika tokom tekuće krize ili su neki održivi potezi politika izostavljeni?

Ključne reči: *kovid 19, odgovori monetarne i fiskalne politike, evrozona.*

Introduction

The ongoing social and economic crisis, frequently called the coronavirus crisis, triggered by the COVID-19 pandemic, represents an unprecedented threat in recent history for Europe and the world. It affects social dynamics and economic activity on both, micro and macro levels. The economic systems are slowing down, and the potential emergence of the consequent recessionary stage is often being compared to the prolonged 2010-2012 sovereign debt crisis outcomes. The COVID-19 crisis once again tests the boundaries of the currency union. Still, the coronavirus crisis has its own unique characteristics. Its catastrophic potential is high although, for months now, it is expected to be temporary. The shock is said to be symmetric, since it affects different economies and EU countries in a similar manner. This paper tries to answer whether proposed and implemented monetary and fiscal actions in the EU represent viable risk mitigating tools for the ongoing crisis. It is devoted to the analysis of already taken and potential anti-crisis monetary and fiscal measures oriented to mitigate the economic impact of the coronavirus crisis on the eurozone countries. The special attention is paid to the Corona bonds and their potential as a risk mitigating instrument.

The paper is organised as follows – analysis begins with the eurozone initial responses and recent monetary decisions of the European Central Bank (ECB). It further focuses on the fiscal and economic strategies employed: the coordination of fiscal policy responses among different states, the role of the European Stability Mechanism (ESM) and, finally, joint debt instruments initiative.

Emerging challenges in the eurozone and initial responses

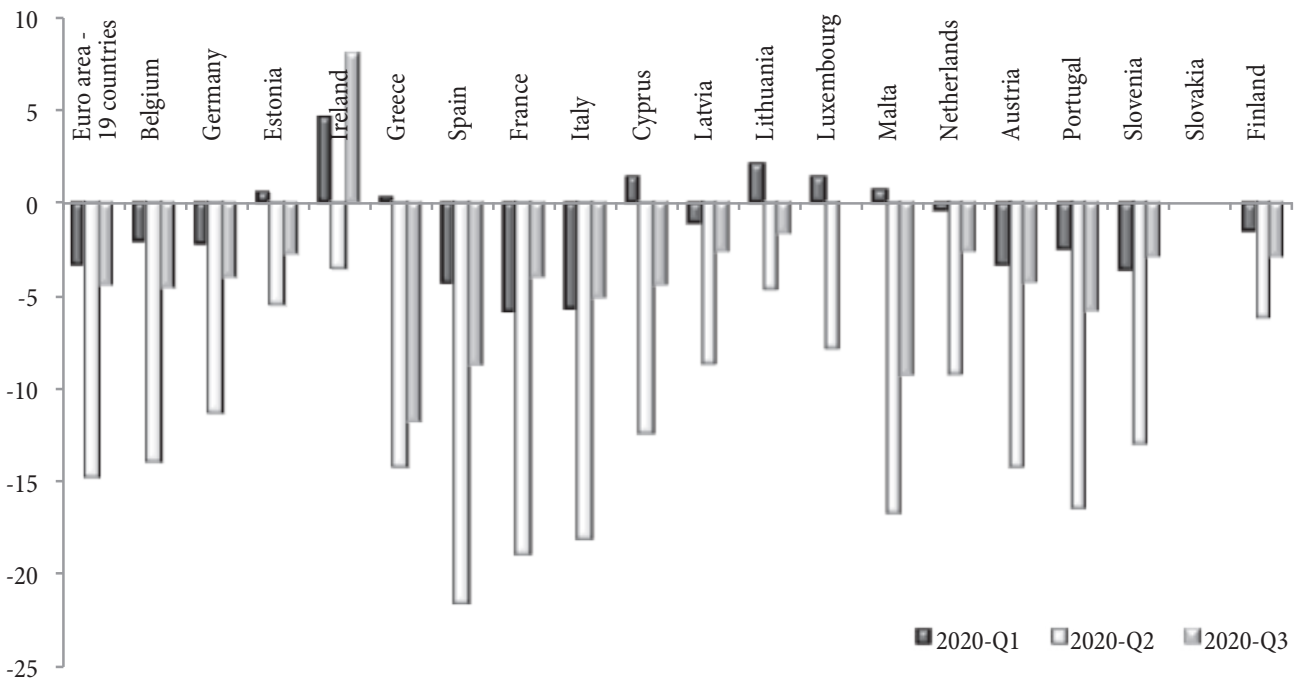
The challenges European economies are currently facing are specific and severe. They are caused by a symmetrical external shock. Unlike the previous debt crisis in the eurozone, it seems that the current crisis does not include high asymmetric information and moral hazard issues.

This type of crisis could potentially reduce the gap between the core and periphery countries of the eurozone. During the 2008 crisis, many analysts confidently predicted the subsequent collapse of the eurozone. But what global financial crisis and debt crisis in the 2010-2012 eurozone brought to light were significant imbalances that Member States had been facing for a long period. The Economic and Monetary Union was not structurally and functionally prepared for financial crisis, and it appears that the ongoing coronavirus crisis represents even a bigger challenge for the whole Union. The economic shock in the present crisis is severe and it is a fiscal rather than monetary challenge. As such, it strikes the central weakness of the eurozone – the absence of the fiscal union.

During the global financial crisis, the banking sector was in the epicentre, and the ECB provided liquidity support to banks and financial markets. The monetary policy instruments represented the first line of defence. During the ongoing COVID-19 crisis, the potential ECB role is to some extent limited since it may not build hospitals, produce medical equipment or organise income support for companies and employees. This remains within the scope of fiscal policy.

The coronavirus crisis affects not only all Member States of the Economic and Monetary Union, but also the entire Europe. The policy reactions to this pandemic have so far been predominantly national. Thus, even in the presence of the symmetric shock, the eurozone responds asymmetrically. The substantial variety in policy responses is amplified by differences in initial conditions. The longer the crisis lasts, the more visible these differences may become.

Figure 1: GDP volume changes for euro area countries during 2020, in %



* Growth rates with respect to the same quarter of the previous year are calculated from calendar and seasonally adjusted figures.
Source: Authors' presentation based on the [25] data.

Figure 1 illustrates GDP volume percentage changes during 2020 for the eurozone Member States, indicating significant fall of economic activity during the year, in particular the second quarter.

There is a risk that the eurozone may repeat the same mistakes from a decade ago. Often delayed responses of the national governments during previous crisis have imposed significant economic costs to their countries.

Similar scenario happened at the beginning of the present crisis. Then, once the ECB announced a new programme of asset purchases to stabilise European markets, the markets started to calm and bond spreads narrowed [19]. The spot rate yield curve of the euro area shifted downwards.

The perceived need for joint fiscal reaction faded, and each Member State turned its attention back to available national rescue packages.

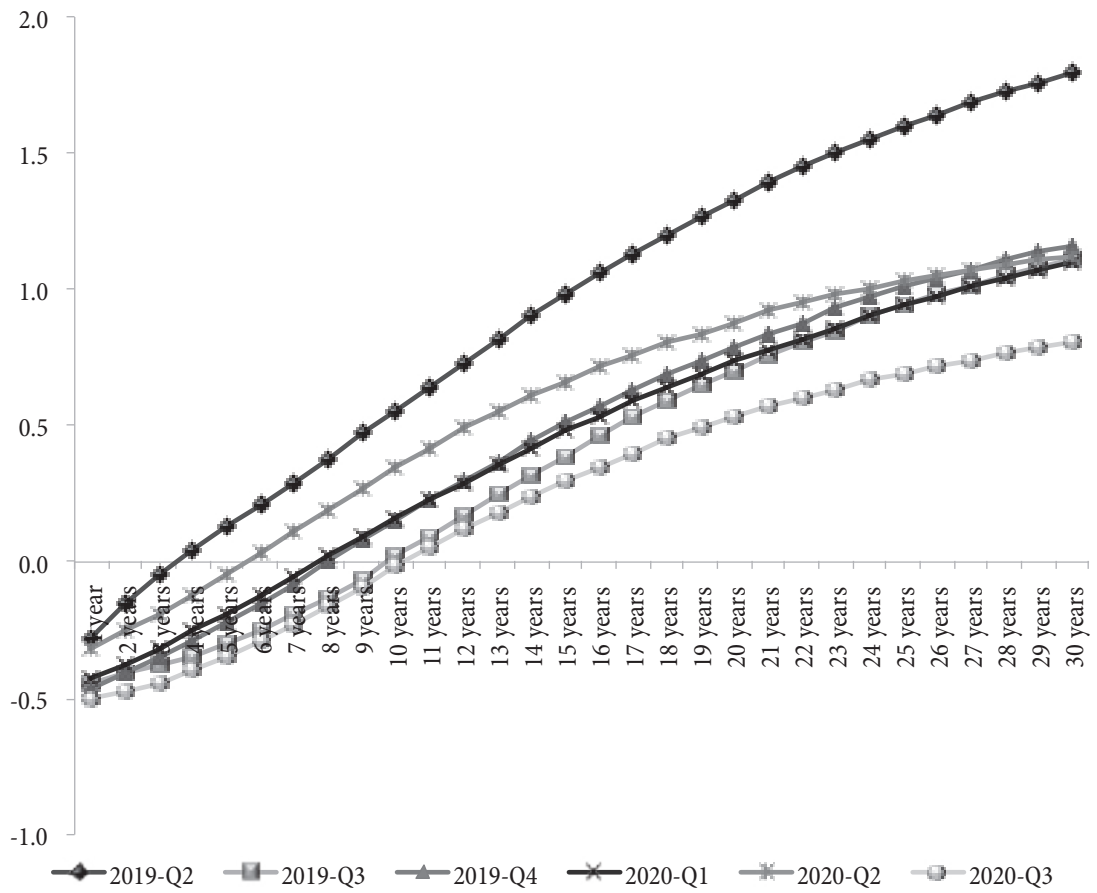
What becomes obvious from the previous crises and the present one is that the eurozone needs a joint fiscal response to the coronavirus crisis in addition to monetary policy measures. A detailed analysis is presented further in this paper.

The European Central Bank monetary policy anti-crisis measures

The provision of the ECB liquidity comes in the form of targeted and non-targeted programmes.

In accordance with the monetary authority decision of 12 March 2020, additional longer-term refinancing operations were announced to be conducted as prompt liquidity support to the eurozone financial system. Considering targeted longer-term refinancing operations, more favourable terms were planned for the period June 2020-June 2021. In addition, net asset purchases of €120 billion would be added until the end of the ongoing year, and reinvestments of the principal payments for maturing instruments under the asset purchase programmes would continue.

Figure 2: Spot rate yield curve – euro area*, in %



* Euro area - All euro area central government bonds.
Source: Authors' presentation based on the [25] data.

The changes in the terms of targeted longer-term refinancing operations - TLTRO III (more favourable interest rate during the period from June 2020 to June 2021 and the increase in the maximum amount that counterparties are entitled to borrow) were followed by a large expansion in the central bank funding of banks. In June 2020, banks bid for a total of €1,308 billion in TLTRO funds, which is the largest amount to date under any single lending operation. In relation to non-targeted programmes, the ECB announced, in April 2020, a series of non-targeted pandemic emergency longer-term refinancing operations (PELTROs). The PELTROs are helping to ensure sufficient liquidity and smooth money market conditions as a response to the crisis [17].

On 18 March 2020, the ECB announced a new temporary asset purchase programme of private and public sector securities in order to preserve monetary policy transmission mechanism. This pandemic emergency purchase programme (PEPP), initially based on the amount of €750 billion, was planned to be conducted until the end of 2020 and to include all the asset categories eligible under the existing asset purchase programmes. PEPP "will be conducted in a flexible manner which allows for fluctuations in the distribution of purchase flows over time, across asset classes and among jurisdictions" [3]. The ECB noted that the Governing Council will consider revisions if it becomes necessary to adjust its action to the level of risk faced.

The limits per issue and issuer under the public sector asset purchase programme (PSPP) will not be applied to PEPP (Article 4 of Decision (EU) 2020/440). The PEPP objective and means fall within the ECB's monetary policy mandate. Regarding prohibition of monetary financing defined in Article 123 of the Treaty on the Functioning of the European Union (TFEU) [22], the European System of Central Banks (ESCB) does not have authority to purchase government bonds on secondary markets under conditions which would practically mean that its action has an effect equivalent to that of a direct purchase of government bonds from the public authorities and bodies of the Member States.

The ECB should not purchase government bonds in primary markets either, as that would mean that it would effectively issue money to finance Member States' budget deficits during the crisis. The grant of financial assistance to the Member States does not fall within monetary policy. Member States are still obliged to conduct sound budgetary policies.

The Governing Council of the ECB decided on 4 June 2020 to increase the size of the PEPP from €600 billion to €1,350 billion and to extend the purchase horizon until at least the end of June 2021. In addition, it decided to set up a new Eurosystem repo facility for non-euro area central banks (EUREP) providing precautionary euro repo lines to non-euro area central banks. EUREP complements the ECB's bilateral swap and repo lines which provide euro liquidity to non-euro area central banks. New bilateral repo lines with Romania, Serbia and Albania were announced during the review period [14].

Coordination of fiscal policy responses within the framework of the Stability and Growth Pact (SGP)

The eurozone represents currency union where fiscal policy is still decentralised and conducted at the national level. Within this framework, fiscal reaction to the COVID-19 crisis was firstly conducted in a decentralised manner. Each Member State was using direct and indirect measures for their declining economies. However, the Eurogroup has offered a platform for coordinated action and fiscal stimulus as reaction to the crisis. In their public statements during March 2020, the EU finance ministers stressed the need for coordinated policy actions.

On 16 March 2020, the Eurogroup held a discussion with non-euro area members on a necessary response to the human and economic crisis caused by the coronavirus. The Eurogroup is committed to effectively addressing challenges, restoring confidence and supporting economic recovery. Exceptional circumstances require employment of all instruments necessary to limit the socio-economic consequences of the COVID-19 outbreak. Thus, the Eurogroup has agreed a first set of national and European measures and set a framework for further actions to support economic recovery. Primary estimates of the European Commission have shown that the total necessary fiscal

support will be very high. Fiscal measures decided to support the economy reach 1% of GDP, on average, for 2020, in addition to the impact of automatic stabilisers. Planned liquidity facilities consisting of public guarantee schemes and deferred tax payments are estimated at the level of at least 10% of GDP. These figures could, however, be much higher till the end of the pandemic period.

The following set of measures was announced to protect economies [10]:

1. National measures
2. Coordinated efforts at the European level
3. Measures to support the economic recovery.

Table 1 below summarises the main economic measures referred to above.

Shared rules discussed include the application of the Stability and Growth Pact, state aid rules and prudential rules:

- The economic shock of the coronavirus, an economic contraction expected this year, together with the cost of agreed measures, will have a substantial budgetary impact. The SGP has the flexibility needed to cope with this situation and will make full use of this flexibility in all Member States.
- Automatic revenue shortfalls and unemployment benefit increases resulting from the fall in economic activity will not affect compliance with the applicable fiscal rules, targets and requirements. The budgetary effects of temporary fiscal measures taken in response to the COVID-19 will be excluded when assessing compliance with the EU fiscal rules, targets and requirements. This includes the budgetary impact of temporary and targeted measures. The European Commission is ready to activate the general escape clause, allowing for further discretionary stimulus, while preserving medium-term sustainability.
- The European Commission provided guidance on the scope for supporting firms that is available within state aid rules in the current situation, and announced that it has accelerated its state aid approval processes. It has also announced that it will approve additional measures needed, which is already the case for Italy and increasingly across the EU. Taking urgent action and making use of the flexibility in the state aid rules is necessary to cushion the effect of the crisis for affected companies and sectors, while ensuring a consistent framework in the single market.

Table 1: National measures, coordinated efforts and measures to help economic recovery at the European level**

1. National measures*	2. Coordinated efforts at the European level
• Fiscal spending focused on controlling and treatment of the disease. Resources are provided to health sectors and civil protection systems;	• The European Commission proposal for a €37 billion "Corona Response Investment Initiative" directed at health care systems, SMEs, labour markets and other vulnerable parts of the economies, supplemented by €28 billion of structural funds eligible for meeting these expenditures;
• Liquidity support for firms facing disruption and liquidity shortages, especially SMEs and firms in severely affected sectors and regions – tax measures, public guarantees to help companies to borrow, export guarantees and waiving of delay penalties in public procurement contracts;	• The European Commission and the EIB Group initiative to mobilise up to €8 billion of working capital lending for 100,000 European firms, backed by the EU budget, by enhancing programmes for guaranteeing bank credits to SMEs. The Commission and the EIB Group even opted to increase this amount to up to €20 billion, which would reach additional 150,000 firms. The Eurogroup tries to make further funds available as fast as possible and to enhance the flexibility of the financial instruments leveraged;
• Support for workers to avoid employment and income losses, including short-term work support, extension of sick pay and unemployment benefits and deferral of income tax payments.	• The ECB package of monetary policy measures aimed at supporting liquidity and funding conditions for households, businesses and banks, to help the provision of credit to the real economy and avoid fragmentation of the eurozone financial markets in order to preserve the transmission of monetary policy;
	• The Eurogroup invited the EIB to further enhance and accelerate the impact of the available resources, also through enhanced collaboration with the National Development Banks;
	• The EIB Group to catalyse €10 billion in additional investments in SMEs and midcaps and to accelerate the deployment of another €10 billion backed by the EU budget.

* All national authorities will allow automatic stabilisers, and in addition implement necessary temporary measures to fight the economic consequences of the coronavirus crisis.

** Measures focused on the resilience of the European strategic value chains to better protect Europe from product and capital market disruptions in the future. Crisis management framework has been significantly strengthened, including the establishment of the ESM. The Eurogroup continues work to further strengthen the resilience to shocks of the Economic and Monetary Union.

Source: European Council, Eurogroup.

- In order to prevent this health crisis from turning into a broad social and economic crisis, the European Banking Authority stated that competent authorities should make full use of the flexibility embedded in existing regulation to support the banking sector in the current circumstances.
- The ECB Banking Supervision is providing temporary capital and operational relief to the eurozone banks, to ensure that supervised banks are able to continue to fund the real economy as the economic effects of the coronavirus crisis become apparent. Such flexibility is needed to mitigate pro-cyclical consequences for the financial sector.

The European Commission has set up several temporary frameworks and significantly relaxed EU rules on state aid or competition law to support measures undertaken at the national level.

On 23 March 2020, the EU finance ministers issued a statement on the Stability and Growth Pact in light of the COVID-19 crisis. They stressed that the coronavirus pandemic led to a major economic shock that already has a significant negative impact in the EU. The size of the consequences will depend on the duration of the pandemic and measures taken at both – national and EU level. They see the importance of the coordinated policy response to limit the duration and the scope of the shock, protect economy and keep sustainability of public finances in the medium term. Ministers of Finance of the Member States agreed with the previously stated assessment of the European Commission that the conditions for the use of the general escape clause of the EU fiscal framework – a severe economic downturn in the euro area or the Union as a whole – are fulfilled. The general escape clause of the Stability and Growth Pact was introduced as part of the "Six-Pack" reform of the Stability and Growth Pact, and seeks to offer Member States the fiscal leeway to deal with periods of "severe economic downturn" (Articles 5(1) and 9(1) of Regulation No. 1466/975 and Articles 3(5) and 5(2) of Regulation No. 1467/975). In contrast to what was disseminated in the press, this clause does not cause a generalised suspension of the SGP. Member States remain obliged by the EU's fiscal rulebook, but they may depart from their 'normal' fiscal trajectory for the purposes of crisis management. The clause, however, represents the most far-reaching form of flexibility under the SGP, and its activation is as significant as it is unprecedented [4, p. 3].

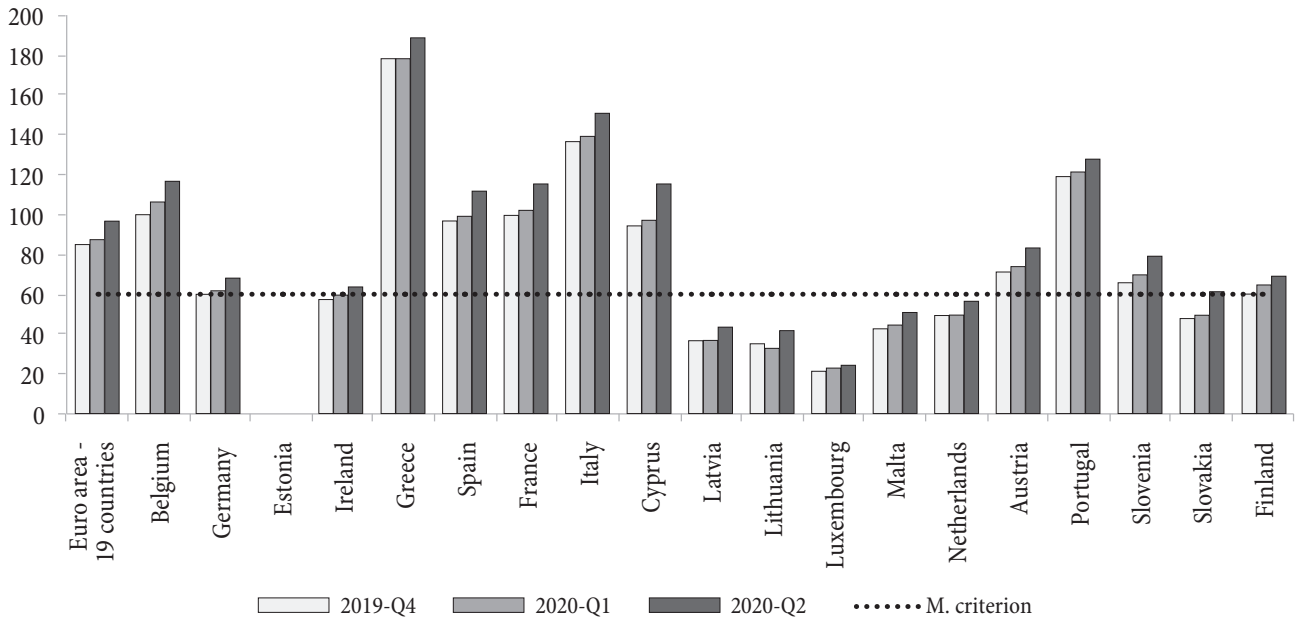
The use of this so-called escape clause is ensuring flexibility to undertake all necessary measures to support health systems, civil protection systems and economies, including further discretionary stimulus and coordinated action that should be timely, temporary and targeted by Member States. Still, EU ministers assure that they remain fully committed to the Stability and Growth Pact. The general escape clause should allow the Commission and the Council to undertake necessary policy coordination measures within the framework of the Stability and Growth Pact, while departing from the budgetary requirements that would normally apply, in order to fight the economic consequences of the crisis. The goal is to address challenges, restore confidence and support fast recovery [11].

The signal sent to the Member States and the public suggests that the former may spend as much as it takes to smooth the effects of the coronavirus crisis. It seems that the debt crisis has taught the EU to appreciate the importance of the timely counter-cyclical and coordinated fiscal stimuli in times of distress.

However, although the EU seems to be very flexible in the ongoing situation, the long-lasting problem of economic and public finance divergence among Member States is still present. Notable is the difference in the capacity to support their economies. For example, when Germany announced a €750 billion rescue package, Italy had a limited response of €28 billion. The significant disparity in the policy response is supported by differences in initial conditions. In 2019, Italian output was 4% lower than in 2007, while German GDP was 16% higher. Due to the ongoing GDP fall, the Italian public debt ratio will soon approach 150% of GDP. The spread, yield differential between Italian and German government bonds, widened substantially in the wake of the crisis [19].

Since the crisis is affecting all EU Member States, a significant increase in public debt levels in all EU countries seems inevitable. However, there is considerable divergence in manoeuvring space that each country has in deficit spending [16, p. 2].

Figure 3: General government gross debt – euro area, as % of GDP



Source: Authors' presentation based on [25] data.

The past and present divergence is the reason why Europe requires a collective fiscal response at the eurozone level. Two options are proposed: relying on the European Stability Mechanism, and/or issuing joint debt instruments.

The European Stability Mechanism

The European Stability Mechanism represents a permanent crisis fund in the EU. Its funding capacity is €410 billion, i.e., 3.4% of the eurozone's GDP.

After the Eurogroup video meeting on 24 March 2020, it was announced that the eurozone finance ministers prefer to use the existing ESM instrument - enhanced conditions credit line, whose features would be consistent with the external and symmetric nature of the coronavirus shock.[1] The mentioned size of the instrument was in the range of 2% of a Member's GDP [12]. On the other hand, Bénassy-Quéré et al. (2020) proposed a new, dedicated COVID credit line with a long duration, access conditions and ex-post conditionality to be added to the list of ESM financial instruments [1].

The present ESM Treaty [20] and the ESM Guideline on Precautionary Financial Assistance [13] define the eligibility criteria and the procedures to be followed by states for granting precautionary financial assistance. Member States however hesitate to oblige themselves to a macroeconomic adjustment programme in order to be able to get precautionary financial assistance, since they are aware that the coronavirus crisis is not their fault and, hence, conditionality in these programmes is highly disputable. In that sense, draft revised ESM Treaty brings important changes to precautionary financial assistance instruments [5]. The access to a precautionary conditioned credit line (PCCL) would no longer require a memorandum of understanding stressing the conditionality to be attached to the programme. It would require the continuous respect of the eligibility criteria listed in draft Annex III, as documented by a letter of intent (Article 14).

Although the technical detail appears to be well defined, unfortunately, the ESM reform has not yet been finalised. At present, none of the Member States would meet the eligibility criteria for PCCL, and it is unclear whether a precautionary credit line would qualify them for access to the outright monetary transactions (OMT). The ECB should clarify its original OMT press release

1 The ESM programme would carry the added advantage that the ECB could implement its outright monetary transactions (OMT) programme, which would involve outright transactions in secondary sovereign bond markets. However, what is required from OMT is "strict and effective conditionality that can take a form of a full EFSF/ESM macroeconomic adjustment programme or a precautionary programme (enhanced conditions credit line, ECCL), provided that they include the possibility of EFSF/ESM primary market purchases" [6].

and state that a PCCL should be considered sufficient as a pre-condition to activate an OMT programme [2]. This would be preferred by Member States. Conditionality should be tailored to the financial instrument chosen and the economic situation in a particular Member State. It can take the form of continuous regard for pre-established conditions, provided the recipient Member State would conduct a sound budgetary policy. This should not be an issue in the present situation as long as government expenditures are linked to the resolution of the coronavirus crisis.

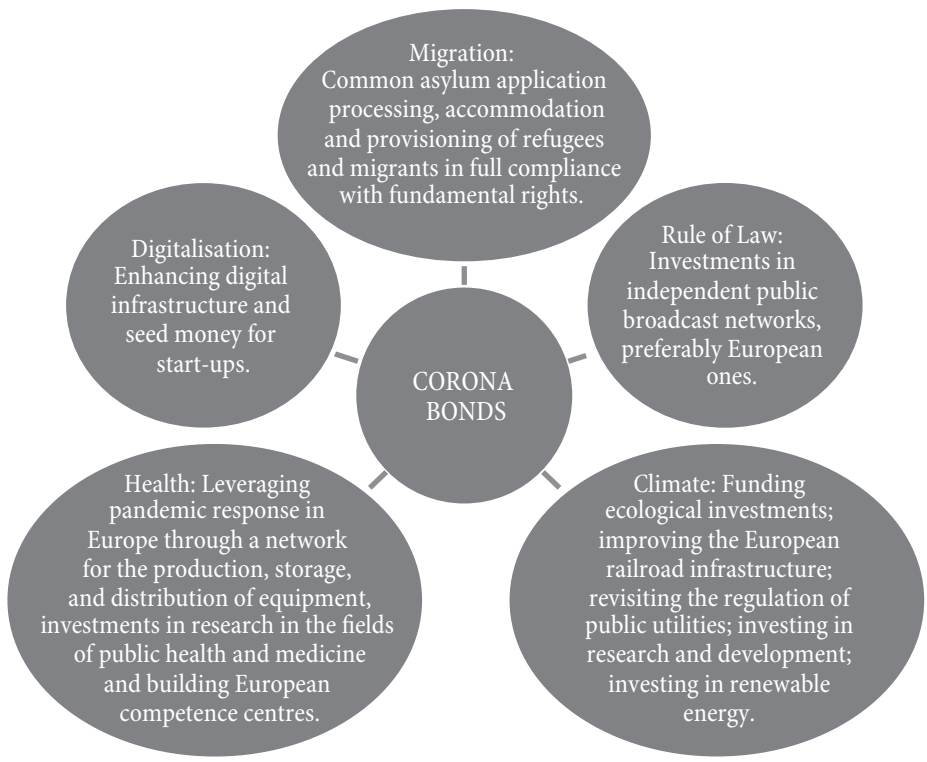
Joint debt instruments – Corona bonds

The most controversial initiative aimed at diminishing the effects of the COVID-19 crisis is the issuance of the joint debt instruments. The idea of the so-called Corona bonds was initially proposed by the Prime Minister of Italy Giuseppe Conte during the European Council meeting of 17 March 2020, and it has received prompt support from France and Spain. Germany and the Netherlands did not reject the idea at the beginning, but they stressed that all other policy options should be considered first. Despite the initiative from nine Member States (Belgium, France, Greece, Ireland, Italy, Luxembourg, Portugal, Slovenia and Spain) for a common debt instrument, the European Council on 26 March 2020 did not reach consensus, and gave the Eurogroup two more weeks to present concrete proposals.

The Corona bonds essentially represent joint debt instruments that are issued at the eurozone level, backed up with collective guarantee from all Member States. The goal is to facilitate access to funding across the eurozone, especially for the states in a weaker financial position. The name of this instrument is new and tailored to the present crisis, but the original idea itself is older and was explored by policymakers during the sovereign debt crisis. Those proposals for the so-called Eurobonds or stability bonds were at the time rejected by the eurozone core countries. The present situation is, however, different. The coronavirus crisis specificities may result in a different response by the eurozone policymakers.

Corona bonds should be beneficial for all Member States. The purpose of these instruments should not be the charity for the weaker states but the protection of the common EU project. The aim is to ensure that Europe

Figure 4: Common EU project financing through joint debt initiative



Source: Authors' presentation.

comes out of this crisis more resistant and ready to meet other challenges which are unsolved but have been temporarily put on hold.

The financing should cover both aspects – partly serve common EU project involving all Member States providing relief to the present crisis, while other part should be made available to individual Member States based on the common programme framework.

Common EU project may include the following elements presented in Figure 4.

Financing lines for individual Member States could include:

1. Healthcare: Investments in hospital infrastructure and the training of doctors and nurses.
2. Labour and Industry: investments in reindustrialisation strategies with a view to re-Europeanise crucial parts of value chains; European wage guarantee funds; survival fund for small businesses (e.g., in the tourism sector); qualification measures, survival fund for crucial infrastructure (e.g., airports and airlines) [15].

Economists have proposed a Corona bonds volume of €1 trillion with longer maturities matching the long-term character of most of the financed projects.

Corona bonds mechanism and their potential advantages compared to the ESM

Each Member State would be responsible for a share of the principal and interest payments of the issued bonds in accordance with the GDP-based contributions to the EU budget. They would fund these payments from their tax revenues. What could also be raised is the special tax revenue for Corona bonds debt servicing. It could be collected on an EU-wide basis through common taxes. Member States' contribution to the debt service of the Corona bonds would mean that each Member State would have to allocate the proportion from its tax revenues that would be transferred to the entity that issues Corona bonds, before meeting other budgetary obligations. This mechanism would result in the debt service made on several bases and it would minimise fear of cross-subsidies between the states. From investors' perspective - it would represent creation of additional safe asset for different institutional and retail investors, since the obligations of the entity issuing the Corona bonds should be joint and several to ensure the highest possible credit rating.

The part of the issued bonds could be GDP-linked or indexed. That would mean that interest and/or principal payments depend on economic development. It would help to avoid pro-cyclical effects and provide fiscal space for the Member States' budgets.

The institutional framework for the issuance of the joint debt instruments remains an open question. The entity that would issue the Corona bonds should be of a long lifespan due to the predominantly long-term nature of the financed projects. The current EU legislation would, however, need to be seriously addressed. The present competencies of the EU under Article 122 of the Treaty on the Functioning of the European Union would likely be overstretched [21, p. 98]. The issue could be resolved by using Article 352(1) TFEU [24, p. 196], but the implementation of measures would require unanimity and might allow certain Member States to block measures introduced to defend the values of the EU stipulated in the Treaty on European Union (TEU). The EU would have to have own rights of taxation, and it would be disputable whether domestic constitutional courts would accept handing significant fiscal power to the Union without a significant change of its institutional framework.

Although the ESM is at the moment an attractive option to many policymakers, since it bears low legal risk from the standpoint of EU treaties, the proposed Corona bonds alternative actually shows the shortcomings of using the ESM in the current form with respect to the ongoing crisis. It has been created for individual Member States in distress, that is, for asymmetric shocks, and it demands strict conditionality.[2] Another major challenge of the ESM funding lines for individual Member States lies in the fact that they increase their level of indebtedness, which may worsen their position. Finally, not all Member States are members of the ESM. The present crisis and recession is the problem that affects the entire EU. The ESM should not become a coronavirus crisis vehicle, since it is planned to be the protector of the eurozone countries.

2 Article 3 ESM Treaty and Article 136(3) TFEU.

Essentially, for the coronavirus crisis, a new vehicle is needed based on, for example, Corona Bond Treaty (CBT) opened to all EU Member States. Since European funding schemes require the consent of Member States' parliaments, it should be suitable to allow for the simultaneous adoption and ratification of a treaty. Administration of the CBT does not require forming of a new institution, since it could be delegated to existing institutions that have the knowledge, experience and capacity to guide the process of issuing and managing bonds. Those could be the European Commission and the ESM. The Commission could be in charge of disbursement and monitoring of funds. The European Parliament and the Court of Justice could ensure strong political and legal accountability. The Member States would have to extend financial guarantees for the CBT. They could be restricted to their share in the fund in accordance with the key for GNI-based contributions or other distribution scheme [22].

The essential prerequisite for CBT to become successful is the assurance that it promotes the fundamental values of the EU. Member States willing to become CBT members should be able to comply with the provisions setting these standards.

The legal issues opened by the issuance of any joint debt instruments remain mostly the same. Primarily, there is the question of competence of the EU to establish a debt mutualisation regime. Further, Corona bonds initiative must not in any essential way contradict the no-bailout clause stipulated by Article 125 TFEU. The clause stresses the necessity of national fiscal responsibility and avoidance of moral hazard in the currency union. The interpretation of this clause was relaxed during the sovereign debt crisis. The advocates of the Corona bonds point out that this Article does not apply to the Corona bonds, since its purpose is to prevent a bailout – the mutualisation of the debt of one or more Member States. As Corona bonds are mutual debt from the very beginning, their mutual character is not a formality and they should fund common European project with some of the revenues. In that respect, they differ from Eurobonds proposal from the previous crisis, which were meant to contribute directly to each Member State's budget. As Article 125(1) TFEU states, its provisions are "without prejudice to mutual financial guarantees for the joint execution of a specific project" [23, p. 99]. It would be the purpose of a CBT to bring Member States back on the path of economic and financial stability. Given the programme character of the CBT, its nature and purpose should not raise a risk of moral hazard.

The CBT, however, raised constitutional issues in some Member States and, in particular, in Germany. Given that the entire or most of the EU-27 would likely participate in a CBT, Germany's share of the burden would not be much larger than its share in the ESM, if measured in absolute numbers. The CBT would not be financed through specific taxes and the members would have to pay contributions in accordance with their share of the GNI contributions to the EU budget. The usage of funds would not be asymmetric as in the case of the ESM.

The CBT would, however, have significant fiscal power. The European Parliament could have a much stronger role than in the case of the ESM, including the right to approve the annual CBT budget. Nevertheless, essential financial decisions, including the adoption or modification of project lines, might still require the consent of the Bundestag. For this reason, a possible CBT would require unanimity for key financial decisions, both on the asset and on the liability side of the balance sheet.

The latest policy actions

European Union leaders agreed in July 2020 on a €1.8 trillion spending package oriented at unprecedented economic downturn in the EU. They ultimately agreed on a €750 billion recovery plan. Of that, €390 billion is to be offered in grants and the rest in the form of loans. Additionally, the agreement was made on a seven-year EU budget of over €1 trillion in the period 2021-2027 [18].

Despite long-standing opposition to joint debt issuance from the core eurozone members, on 20 October 2020, the EU raised €17 billion from the sale of 10- and 20-year social bonds for its SURE unemployment scheme. The demand, predominantly by international investors, was 14 times higher than the offer. It presented the first stage of the EU's plan to fund two support programmes for Member States that will channel funding to the countries hardest hit by the pandemic and consequent

economic losses. The plan is to issue €100 billion of bonds under the SURE programme. So far, three transactions in the period from late-October to end-November were completed, through which 15 EU Member States received €40 billion [7]. These issuances bring EU closer than ever to debt mutualisation.

Conclusion

The COVID-19 crisis represents an unprecedented global event in recent history that severely affects different countries and regions worldwide. The aim of this paper was to provide a critical overview of economic policy responses to the ongoing crisis in the EU and, in particular, the eurozone. The analysis began with the eurozone initial responses and recent monetary decisions of the European Central Bank. In further sections it focused on fiscal and economic strategies: the coordination of fiscal policy responses among different states, the special role of the European Stability Mechanism and the important joint debt proposal.

Corona bonds initiative seems viable and necessary to protect the common European project. While being aware of the fact that this idea deeply encroaches on the essential constitutional questions of the EU, it provides opportunity for consolidated and timely action that may help resolution of the ongoing economic and social crisis. It remains to be seen how Corona bonds might be structured and to what extent constitutional constraints will limit the realisation of this EU protection-oriented project. The alternative to debt mutualisation would be a permanent conditionality through more centralised fiscal policy.

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QUALITY MANAGEMENT AND BUSINESS PERFORMANCE OF SERBIAN COMPANIES*

Menadžment kvaliteta i poslovne performanse preduzeća u Srbiji

Abstract

The impact of quality management (QM) programs on business results has been the subject of numerous studies worldwide. However, given the complexity of the contemporary QM paradigm and its context-dependence, it is difficult to generalise its impact on business performance. This study examines QM from the strategic management perspective by comprehensively analysing the effects of quality management system (QMS) certification to ISO 9001 in terms of improved business performance and the achieved level of total quality management (TQM) in Serbian companies. Control variables of industry type and company size are employed to observe their possible impact on motives for, and effects of, QMS certification to ISO 9001. The results reveal that the certification of Serbian companies' QMS to ISO 9001 positively influences their operational and market performance, with the impact intensity dependent upon company size and industry type. The impact of certification on financial performance was examined but not confirmed. Compared to companies motivated primarily by marketing interests and market pressure, companies that certify their QMS to ISO 9001 to improve the quality of their business show a higher level of TQM implementation and gain greater benefits from certification.

Keywords: *quality management system (QMS); ISO 9001; total quality management (TQM); business performance; strategic management.*

Sažetak

Uticaj programa upravljanja kvalitetom na poslovne performanse postao je predmet brojnih studija širom sveta. Međutim, s obzirom na složenost savremene paradigme upravljanja kvalitetom i njenu kontekstualnu zavisnost, teško je generalizovati taj uticaj. Ovaj rad analizira menadžment kvaliteta iz perspektive strategijskog menadžmenta putem sveobuhvatnog istraživanja efekata sertifikacije sistema upravljanja kvalitetom prema zahtevima standarda ISO 9001 u pogledu poboljšanih poslovnih performansi i dostignutog nivoa menadžmenta ukupnog kvaliteta u preduzećima u Republici Srbiji. Kontrolne varijable vrsta industrije i veličina preduzeća korišćene su u cilju sagledavanja njihovog mogućeg uticaja na motive i efekte sertifikacije. Rezultati sprovedenog istraživanja pokazuju da sertifikacija sistema menadžmenta kvaliteta prema zahtevima standarda ISO 9001 pozitivno utiče na operativne i tržišne performanse preduzeća u Republici Srbiji, pri čemu intenzitet tog uticaja zavisi od veličine preduzeća i vrste industrije. Uticaj sertifikacije na finansijske performanse je ispitan, ali nije potvrđen. U poređenju sa preduzećima koja su prvenstveno motivisana marketinškim interesima i pritiskom tržišta, preduzeća motivisana poboljšanjem kvaliteta poslovanja pokazuju viši nivo implementacije menadžmenta ukupnog kvaliteta i ostvaruju veće koristi od sertifikacije sistema menadžmenta kvaliteta prema zahtevima standarda ISO 9001.

Ključne reči: *sistem menadžmenta kvaliteta; ISO 9001; menadžment ukupnog kvaliteta; poslovne performanse; strategijski menadžment.*

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Introduction

Quality permeates all activities that constitute the value chain of a company, giving quality management (QM) a strategic importance. The ability to manage quality effectively determines the business success of companies, their survival, growth and prosperity. In such conditions, QM implies a focus on all activities and processes of the company, and the involvement of all employees. Requirements for continuous improvement of quality represent a special and significant dimension of a company's strategic orientation. The digital era is a new context of QM characterised by the exponential growth of opportunities. The ways of living, working and connecting are fundamentally changing. The Industry 4.0 solutions enable the emergence of combinatorial innovations which represent a key driver of growth [15]. As intelligent technologies offer more functionality and flexibility [16], they can be perceived as key enablers for improving the quality of goods and processes, as well as for improving the agility of modern enterprises. Further, new technologies enable cooperation between different fields and thus open new frontiers of business development [14]. Therefore, the implementation of the various innovative technologies on which Industry 4.0 is based, as a revolution not only in the field of production, has a special significance in the QM process.

Owing to its characteristics and potency, intellectual capital (IC) provides key support to the QM process. Namely, the changes to which we are direct witnesses and which concern the sources of competitive advantage and drivers of competitiveness are inseparable from IC and its growing importance [7, 13]. Through the QM process, companies exploit and increase the value of its IC. We can see the importance of IC by the fact that its share of the total assets of companies in the S&P 500 during 1975–2015 increased from 17% to 84% [36]. In most OECD countries, investments in intangible assets are growing rapidly, and in some cases, approaching or even exceeding investments in tangible assets. The growth of global competition, information and communication technologies (ICTs), new business models and the growing importance of the service sector is making IC more important for businesses, industries and national economies [38, 39].

QM attracted a great deal of attention from theorists and practitioners given its history of dramatically improving the business performance of companies. However, it also becomes the subject of criticism, particularly in cases of ineffective implementation. The effective implementation of QM sometimes requires changes to a firm's existing practices and its employees' ways of thinking. The motivation of managers and employees plays an important role in quality improvement; motivation comes from being aware of the importance of quality for the company's success, learning, being rewarded for quality improvements, and possessing the necessary resources. Unclear priorities and competing company goals most often have a negative impact on employees' attitudes towards quality, which is why it so important to integrate QM into the strategic management process. The Balanced Scorecard as a strategic management tool can significantly help address this issue. Nicoletti and Oliveira [35] note that the strategic orientation of the company towards quality by using the Balanced Scorecard enables continuous monitoring of the quality management system's (QMS) performance and timely reactions in order to achieve the set goals. Janošević and Dženopoljac [23] state that the Balanced Scorecard provides comprehensive and focused monitoring of total quality management (TQM) results, and enables breakthrough results and the discovery of completely new processes. In this regard, companies can expect significantly better QM effects if they use the Balanced Scorecard as a platform for its implementation. Basir and Davies [4] point out that in order to achieve superior performance, organisations should adopt ISO 9000 standards as strategic management practices, stating that resource allocation and commitment during the implementation process of ISO 9000 principles positively impact performance. The ISO 9004:2009 standard is the first quality system standard that provides recommendations on how to manage an organization in order to achieve sustainable business success, and its scope covers the expectation of all stakeholders, especially the ones of capital owners [3].

Using modern performance measurement systems that include financial and non-financial performance

measures, this study comprehensively examines the impact of QM on different types of business performance. Specifically, we analyse the improvement of business performance after the companies' QMS certification to ISO 9001; the impact of certification incentives on the motives for, and the effects of, certification; and the level of TQM implementation in companies depending on the certification incentives. We include company size and industry type in the model as control variables.

The rest of this paper proceeds as follows. Section 2 develops research hypotheses in relation to the literature and previous research. Section 3 describes the research methodology, including sample definition and identification of variables. Section 4 presents empirical findings, and Section 5 is devoted to discussion and conclusions, including theoretical contribution and managerial implications, as well as limitations and recommendations for the future research.

Theoretical Development and Hypotheses

Investigating the effects of ISO 9000 standards implementation, Melão and Guia [32] conclude that these standards contribute to process improvement, employee motivation and internal communication. Although the implementation of the standards impose a greater administrative burden, employees were better organised and more prepared to tailor their work to the specific needs of users. Ochieng et al. [37] find that certification has a positive effect on return on assets (ROA). Psomas et al. [44] conclude that the effective implementation of ISO 9001 directly affects operational performance, and indirectly affects financial performance. Since the newer version of ISO 9001 contains guidelines for building a culture of excellence, attention should be paid to the conclusion of Rezaei et al. [45] that there is a significant positive relationship between a culture of excellence and organisational performance.

Improved productivity, organisation, communication, employee motivation and defect reduction are most often cited as internal benefits of certification [24], while the most significant external benefits are reduced customer complaints, improved communication with customers and stakeholders, increased customer satisfaction and improved image [20]. Yaya et al. [53] state that the relationship between customer satisfaction and loyalty is about 47% stronger in the case of banks with ISO 9001 certification. Corbett et al. [10] conclude that significant improvement of a company's financial performance can be observed three years after the certification. Benner and Veloso [5], on the other hand, find that companies that certify their QMS later than their industry peers derive less financial benefits compared to companies certified earlier. Numerous studies [17, 27, 29, 30, 48] through different approaches conclude that certification does not produce evident effects on the company's financial performance. Contextual factors such as motivation for certification, QM experience in the company, implementation strategy, employee involvement, and monitoring of operations in accordance with the standard guidelines and requirements can explain the differing effects of certification across companies [40]. Additionally, some research shows that the effects of certification vary by sector [51], company size [41, 47] and technological focus [5]. The literature discussed above leads to the following hypotheses:

H1a. QMS certification to ISO 9001 contributes to the improvement of the company's operational performance.

H1b. QMS certification to ISO 9001 contributes to the improvement of the company's market performance.

H1c. QMS certification to ISO 9001 contributes to the improvement of the company's financial performance.

There is general agreement among researchers that the certification incentives are internal and external [8, 22, 26, 28, 30, 43, 46]. External incentives relate to certain external pressures (competition, customers, government, etc.) or improving the image of the company. On the other hand, internal incentives refer to improving product and service quality, reducing costs, and improving internal efficiency. Valmohammadi and Kalantari [52] conclude that companies certified to ISO 9001 achieve superior performance over non-certified companies. Additionally, they find that internal incentives are positively related to companies' performance. Martinez-Costa et al. [30] find that TQM and certification have a positive effect on a company's business performance, and that internal certification incentives have a greater impact on the business performance than external incentives. They also find that internally motivated companies achieve a higher level of

TQM implementation compared to externally motivated ones, whereby TQM implementation level is determined by evaluating TQM key success factors. Milovanović and Janošević [34] found that TQM positively impacts market and financial performance of Serbian companies which have certified their QMS to ISO 9001. Prajogo [43] points to a positive relationship between internal certification incentives and operational performance, though finds no statistically significant relationship with performance in the case of external certification incentives. Llopis and Tari [28] find that companies that are internally motivated for certification show a higher level of TQM implementation and achieve greater profitability. Certification incentives are a potential answer to the question of why some businesses fail even though they certified QMS to ISO 9001.

Companies certify their QMS to ISO 9001 with the assistance of certification bodies, which act as consultants leading the entire process of adapting a company to the standard requirements, and ultimately awarding the certificate when the requirements are fulfilled. However, a parallel can be drawn here with the research of Holmemo et al. [21] who, in the lean thinking example, state that external experts can hardly bring and install concepts related to the 'soft' elements of business, which include relationships within the organisation and with stakeholders, and organisational learning and continuous improvement, as is the case with the TQM concept and ISO 9001 certification. In addition to the certification incentives, management's ability to embrace the new philosophy of business plays a significant role, as well as the ability and desire of consultants to convey these soft elements to the client. The lack of commitment and support from managers is the main reason for the failure of continuous improvement programs. External certification incentives combined with the profit motives of certification bodies diminish the potential for ISO 9001 implementation to improve business performance. Moreover, a portion of companies implement standards improperly and without commitment, thus certificates have only a formal character [2]. According to the previous discussion, the following hypotheses are suggested:

H2a. Improvement of operational performance after QMS certification to ISO 9001 is more significant in companies with internal certification incentives.

H2b. Improvement of market performance after QMS certification to ISO 9001 is more significant in companies with internal certification incentives.

H2c. Improvement of financial performance after QMS certification to ISO 9001 is more significant in companies with internal certification incentives.

H3. Internal incentives for QMS certification to ISO 9001 lead to a higher level of TQM implementation in companies than external incentives do.

Djofack, et al. [11] find that company size and age are negatively related to the time and cost of quality system implementation. Galetto et al. [19] point to the impact of company size, regional development and industry type on the effects of QMS certification to ISO 9001, and find that non-certified companies have a higher risk of collapse (bankruptcy, liquidation) compared to certified companies, while the risk is lower three years after certification. These authors further suggest that researchers should evaluate and compare business performance for the same companies before and after certification, instead of comparing business performance to a different control group of companies.

Research Methodology

Survey Design and Data Collection

The research was carried out as a part of doctoral dissertation [33] that includes 141 companies from the Republic of Serbia with a valid certificate of conformity of their QMS with ISO 9001 standard requirements. Most previous research on this and similar topics compare the performance of sample companies to that of a control group (e.g. certified vs. non-certified companies, award winners vs. non-award winners, and so on). Such an approach raises questions about the accuracy of the conclusions drawn because they compare non-homogeneous groups of companies, meaning that the structure of the groups in terms of company size, maturity, type of activity and the like could affect the results. This study compares performance for each company individually before and after certification, thereby eliminating the risk of aggregating results. It evaluates the impact of certification on business results based on quality managers' perceptions and objective performance measures.

This study involved academic experts and quality managers from companies with a good reputation for quality in the design and testing of the questionnaire in order to make it fully understandable to respondents, and to ensure the most useful inputs for research. The final version of the questionnaire was sent to 228 e-mail addresses of quality managers who previously gave oral consent by telephone to participate in the survey, and the response rate was 64%.

Variables

The independent variables in this study are the incentives for QMS certification to ISO 9001 and the TQM key success factors which determine the level of TQM implementation. The known TQM key success factors [1, 6, 18, 42, 50] became the basis for the following combination of TQM factors: Customer orientation, Top management commitment, Employee focus, Process approach, Continual improvement, Information and analysis, Supplier relationship and Corporate social responsibility. The latter has been added given its growing importance in evaluating the quality of a business as reflected in its relationships with the community and the environment. Claver-Cortés et al. [9] demonstrate empirically that hotels with a greater commitment to TQM are more interested in environmental management practices. Respondents evaluated each TQM key success factor by assessing 5 statements in a questionnaire on a five-point Likert scale (1 = absolutely disagree, 5 = absolutely agree). The questionnaire is formulated similarly to earlier studies [1, 9, 12, 25, 29, 31, 42, 49, 50].

This study uses operational performance measures (employee productivity, employee satisfaction and employee fluctuation), market performance measures (market share, customer satisfaction and customer retention rate) and financial performance measures (return on assets – ROA, return on equity – ROE, and return on sales – ROS) as dependent variables. Quality managers estimated the improvements in operational and market performance after certification using a five-point Likert scale (1 = significantly less, 5 = significantly higher). Improvements in financial performance are determined using secondary data from companies' publicly available annual financial statements for the year in which the certification occurred, as well as for the third year after the certification. Industry type and company size are control variables included to observe their possible impact on the motives for, and effects of, certification.

Analysis and Results

This study describes the parameters of significance using their frequencies, arithmetic mean and standard deviation. An ANOVA with a Tukey test, SPANOVA, T-test, X^2 test and univariate linear regression are used to test the hypotheses. The probability level is set at $p < 0.05$, and data is analysed using SPSS v 21. The Cronbach's Alpha coefficients, which ranged from 0.735 to 0.876, confirm the reliability of the perceptual measures. Table 1 presents the descriptive indicators of the measured parameters.

Table 1: Descriptive statistics of the measured parameters

	N=141
TQM critical success factors	M ± SD (Min-Max)
Customer orientation	4.47±0.54 (1.60-5.00)
Top management commitment	4.33±0.56 (2.80-5.00)
Employee focus	4.12±0.69 (2.00-5.00)
Process approach	4.19±0.66 (1.40-5.00)
Continual improvement	4.31±0.62 (2.20-5.00)
Information and analysis	4.15±0.70 (2.20-5.00)
Supplier relationship	4.25±0.54 (2.80-5.00)
Corporate social responsibility	4.20±0.66 (2.40-5.00)
Financial performance measurements	M ± SD (Min-Max)
ROA before QMS certification to ISO 9001	0.12±0.28 (-2.23 - 0.84)
ROA after QMS certification to ISO 9001	0.09±0.32 (-2.92 - 1.25)
ROE before QMS certification to ISO 9001	0.22±0.67 (-5.84 - 1.86)
ROE after QMS certification to ISO 9001	0.17±0.39 (-1.89 - 1.25)
ROS before QMS certification to ISO 9001	0.06±0.24 (-1.40 - 1.10)
ROS after QMS certification to ISO 9001	0.02±0.26 (-1.50 - 0.55)
Perceptual improvement after QMS certification to ISO 9001	M ± SD (Min-Max)
Operational performance	3.69±0.61 (2.33-5.00)
Market performance	4.12±0.59 (3.00-5.00)
Incentives for QMS certification to ISO 9001	n(%)
External	24 (17.6%)
Internal	108 (79.4%)
Both external and internal	4 (3.0%)

Table 1 indicates that there was improvement in the companies' operational and market performance after QMS certification to ISO 9001. In this regard, the results confirm hypotheses H1a and H1b. The ANOVA test determines whether a statistically significant difference between companies of different sizes (micro, small, medium and large) exists in terms of operational and market performance improvement after certification (Table 2). As a statistically significant difference exists for the variable Market performance is (F = 3.51, p = 0.02), Tukey test is employed to determine the nature of this difference. The results show that the improvement of market performance after certification was more significant in medium and small companies compared to large and micro companies.

An ANOVA test also checks for a statistically significant difference between companies belonging to different types of industries (manufacturing, trade, services) in terms of operational and market performance improvement after QMS certification to ISO 9001 (Table 3). As a statistically

Table 2: Improvement of operational and market performance after QMS certification to ISO 9001 by company size

	Company size											
	Micro		Small		Medium		Large		Total		F	p
	M	SD	M	SD	M	SD	M	SD	M	SD		
Operational performance	3.69	0.56	3.73	0.69	3.72	0.58	3.49	0.48	3.69	0.62	0.76	0.52
Market performance	3.94	0.59	4.22	0.55	4.22	0.63	3.79	0.54	4.12	0.59	3.51	*0.02*

M – arithmetic mean; SD – standard deviation; F– ANOVA test; p – statistical significance;

Table 3: Improvement of operational and market performance after QMS certification to ISO 9001 by industry type

	Industry type									
	Manufacturing		Trade		Service		Total		F	p
	M	SD	M	SD	M	SD	M	SD		
Operational performance	3.63	0.57	4.10	0.69	3.67	0.65	3.69	0.61	4.30	*0.02*
Market performance	4.11	0.56	4.23	0.63	4.09	0.68	4.12	0.59	0.32	0.72

M – arithmetic mean; SD – standard deviation; F– ANOVA test; p – statistical significance;

Table 4: Control variables and financial performance change after QMS certification to ISO 9001

	ROA		ROE		ROS	
	before ISO 9001	after ISO 9001	before ISO 9001	after ISO 9001	before ISO 9001	after ISO 9001
INDUSTRY TYPE						
Manufacturing	0.09±0.31	0.07±0.35	0.24±0.41	0.13±0.41	0.05±0.27	0.01±0.28
Trade	0.19±0.21	0.11±0.15	0.42±0.50	0.29±0.33	0.08±0.09	0.03±0.22
Services	0.17±0.22	0.15±0.28	0.07±1.19	0.26±0.36	0.10±0.25	0.07±0.25
Total	0.12±0.28	0.10±0.32	0.22±0.68	0.18±0.40	0.06±0.25	0.03±0.27
Wilks' Lambda	0.998		0.969		0.999	
F test	0.114		1.916		0.059	
Partial Eta²	0.002		0.031		0.001	
p-value	0.893		0.152		0.943	
COMPANY SIZE						
Micro	0.07±0.65	-0.04±0.80	0.56±0.55	0.28±0.37	0.09±0.12	-0.02±0.26
Small	0.15±0.19	0.13±0.16	0.29±0.34	0.25±0.30	0.12±0.13	0.08±0.17
Medium	0.12±0.17	0.11±0.13	0.02±1.14	0.07±0.47	0.03±0.38	-0.01±0.39
Large	0.09±0.17	0.09±0.18	0.07±0.45	0.05±0.51	-0.03±0.26	-0.01±0.28
Total	0.12±0.28	0.10±0.32	0.23±0.68	0.18±0.40	0.07±0.24	0.03±0.27
Wilks' Lambda	0.993		0.980		0.978	
F test	0.294		0.787		0.888	
Partial Eta²	0.007		0.020		0.022	
p-value	0.830		0.503		0.449	

significant difference exists for the variable Operating performance (F = 4.30, p = 0.02), the Tukey test is applied to determine the nature of the difference. The results show that the improvement of operational performance after QMS certification to ISO 9001 is more significant in trade than in manufacturing and service companies (M = 4.10 vs. M = 3.63; and M = 3.67).

The SPANOVA test examines whether the values of financial performance measures changed significantly after the certification (Table 4). The results show no statistically significant difference. In this regard, the results do not confirm hypothesis H1c. The SPANOVA test results also reveal that industry type and company size did not have a statistically significant effect on the change in financial performance after certification.

An investigation of the impact of certification incentives on operational and market performance using linear regression (Table 5) followed the definition of certification incentives as a dummy variable (Primarily External Incentives = 0, Primarily Internal Incentives = 1). The positive regression coefficient indicates that internal certification incentives have a greater positive impact on operational and market performance than do external certification incentives. The average values of operational performance for companies with external incentives are 3.34 ± 0.49, while for companies with internal incentives average values are 3.80 ± 0.60. The average values of market performance for companies with external certification incentives are 3.72 ± 0.54, while for companies with internal incentives, the values are 4.22 ± 0.54. Therefore, hypotheses H2a and H2b are confirmed.

The SPANOVA test results confirm a statistically significant impact of certification incentive on the change in ROS, but not ROA or ROE (Table 6). Companies with internal certification incentives face a milder ROS drop than companies with external certification incentives. However, given that financial performance has not improved after certification, H2c is not confirmed.

The T-test checks for a statistically significant difference in the level of TQM implementation according to companies' certification incentives (Table 7). The results show that internal certification incentives have a stronger positive impact on the TQM key success factors of Process approach, Information and analysis and Corporate social responsibility, than external certification incentives do, thus confirming hypothesis H3.

The χ^2 test examines of the influence of industry type and company size on the certification incentives. The results reveal that the percentage of companies driven by external certification incentives was highest among service companies and significantly lower among trade and manufacturing companies (Table 8), while there is no statistically significant impact of company size on the certification incentives (Table 9).

Table 5: Impact of certification incentives on operational and market performance improvement after QMS certification to ISO 9001

Dependent variable	Independent variable	Univariate linear regression		
		Beta (95%CI)	p	Adjusted R^2
Operational performance	Certification incentives	0.293 (0.196–0.722)	*0.001*	0.079
Market performance	Certification incentives	0.330 (0.246–0.754)	*0.000*	0.102

Table 6: Certification incentives and financial performance change after QMS certification to ISO 9001

	ROA		ROE		ROS	
	before ISO 9001	after ISO 9001	before ISO 9001	after ISO 9001	before ISO 9001	after ISO 9001
CERTIFICATION INCENTIVES						
External	0.12±0.13	0.07±0.15	0.35±0.51	0.25±0.42	0.13±0.25	-0.04±0.34
Internal	0.12±0.31	0.10±0.36	0.19±0.73	0.17±0.40	0.06±0.20	0.04±0.25
Total	0.12±0.28	0.09±0.33	0.22±0.69	0.18±0.40	0.07±0.21	0.03±0.27
Wilks' Lambda	1.000		0.995		0.928	
F test	0.039		0.598		9.245	
Partial Eta²	0.000		0.005		0.072	
p-value	0.844		0.441		*0.003*	

Table 7: Certification incentives and the TQM key success factors

	Certification incentives	M	SD	t	df	p
Customer orientation	External	4.30	0.48	-1.80	126.00	0.074
	Internal	4.52	0.54			
Top management commitment	External	4.20	0.53	-1.26	122.00	0.211
	Internal	4.36	0.56			
Employee focus	External	3.93	0.73	-1.37	126.00	0.174
	Internal	4.16	0.69			
Process approach	External	3.88	0.74	-2.64	123.00	*0.009*
	Internal	4.26	0.61			
Continual improvement	External	4.17	0.78	-1.26	125.00	0.212
	Internal	4.35	0.56			
Information and analysis	External	3.82	0.73	-2.83	125.00	*0.005*
	Internal	4.25	0.66			
Supplier relationship	External	4.13	0.57	-1.23	127.00	0.221
	Internal	4.28	0.52			
Corporate social responsibility	External	3.76	0.61	-3.86	128.00	*0.000*
	Internal	4.31	0.63			

M-arithmetic mean; SD – standard deviation; t – t-test; df – degree of freedom; p – statistical significance

Table 8: Relationship between certification incentives and industry type

			Certification incentives		Total
			External	Internal	
Industry type	Manufacturing	Total	11	77	88
		%	12.5%	87.5%	100.0%
	Trade	Total	3	13	16
		%	18.8%	81.2%	100.0%
	Service	Total	10	18	28
		%	35.7%	64.3%	100.0%
Total		Total	24	108	132
		%	18.2%	81.8%	100.0%

χ^2=7.69, df=2, p=*0.021*

Table 9: Relationship between certification incentives and company size

			Certification incentives		Total
			External	Internal	
Company size	Micro	Total	4	12	16
		%	25.0%	75.0%	100.0%
	Small	Total	13	45	58
		%	22.4%	77.6%	100.0%
	Medium	Total	5	30	35
		%	14.3%	85.7%	100.0%
	Large	Total	2	17	19
		%	10.5%	89.5%	100.0%
Total		Total	24	104	128
		%	18.8%	81.2%	100.0%

χ^2=2.22, df=3, p=0.528

Discussion and Conclusions

Theoretical Contributions

The literature on the impact of companies' QMS certification to ISO 9001 on business performance has offered mixed findings. The results of the present study reveal that the certification of QMS to ISO 9001 contributes to the improvement of a company's operational and market performance. Other authors reach the same conclusions using different performance measures [20, 24, 32, 44, 53]. We also join a group of authors who find no impact of certification on financial performance [17, 27, 29, 30, 48]. The type of incentives prompting QMS certification to ISO 9001 affects the TQM implementation level in companies and company performance. Companies driven by internal certification incentives show a higher level of TQM implementation [28] and benefit more from certification in terms of operational and market performance than companies driven by external incentives, a finding that matches with previous research results [30, 43, 52]. Although there is no statistically significant change in financial performance due to certification, the results indicate that companies with internal incentives face milder ROS fall compared to companies with external incentives.

By including the control variables of industry type and company size, this study finds that service companies are driven more by external certification incentives compared to manufacturing and trade companies. Medium and small companies realise a more significant improvement in market performance after certification relative to micro and large companies, while trade companies realise a more significant improvement in operational performance after certification compared to manufacturing companies.

Managerial Implications

This study also makes a practical contribution, as it explains the link between QM and business performance in a systematic and comprehensive manner, which can be of great importance for managers to understand and successfully implement QM practices. It is important to embrace QM as part of a strategy for achieving sustainable competitive advantage and long-term profitable growth, rather than as an administrative innovation whose implementation burden falls on the executives and managers in the lower levels of the organisational structure. In order to create higher value for customers, and consequently for owners as the ultimate goal of a business, it is necessary for QM to become part of a strategic determination by the company to build success on the basis of quality. Unfortunately, in many developing countries the awareness of the importance of quality as a strategic resource, which contributes to the development of IC as a basis for future sustainable growth of the company, is still not sufficiently developed. The use of strategic management tools such as the value chain and the Balanced Scorecard, as well as modern performance measurement systems, can significantly contribute to increasing the efficiency of QM implementation.

Limitations and Direction for Future Research

Collecting data based on respondents' assessments has significant limitations regarding objectivity issues. A case study would be preferable over a questionnaire to improve the reliability of the data used in future research. This approach would enable the researcher to measure all research inputs and thereby determine whether a company made progress in QM practices and how the progress affected its business performance. Although such a process may be time-consuming, it would help to increase the reliability of the study results. The present research uses a period of three years to observe the impact of QMS certification to ISO 9001 on the business performance of Serbian companies. As we find no evidence of improved financial performance, future research could examine a longer time period after certification. More research on this and similar topics in developing countries would have a positive impact on raising the awareness about the strategic importance and effective implementation of QM practices. The research question suggests another potential trajectory of research: how can businesses harness the potency of IC and ensure its support to improve the QM process?

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COVID-19 IMPACT ON CULTURAL AND NATURAL PAN-EUROPEAN THEMATIC ROUTES

Uticaj kovida 19 na panevropske kulturne i prirodne tematske rute

Abstract

Although the definitive effect is not measurable yet, it is evident that the hospitality and tourism sectors have endured the greatest pressure in the coronavirus pandemic crisis. This paper presents the analysis of the impact of the crisis on the thematic tourism routes. The emphasis is placed on investigating the impacts on market structure and seasonality, being the external dimensions, and on employment and cost-controlled measures as instruments of the internal management dimension. The case study analysis employed is based on the empirical examples of Pan-European thematic routes titled "Roman Emperors & Danube Wine Route" (RER & DWR) and "Via Dinarica Route" (VDR). The paper also discusses models of various scenarios for business recovery and further development. The findings show that COVID-19 has had a minimal impact of -2% on employment in the thematic routes and that massive cost control measures have been predominantly aimed at fixed operational costs. Thematic routes have experienced a decrease in operating time of up to 50%, and at the same time are undergoing market restructuring, with domestic and regional guests being the leading segments. Research further shows that the most needed form of government support through crisis mitigation measures is destination promotion support, followed by wage support and utility cost reduction.

Keywords: *COVID-19, thematic routes, cultural routes, tourism, performances.*

Sažetak

Uprkos tome što konačni efekti još uvek nisu merljivi, evidentno je da su ugostiteljski i turistički sektor pretrpeli najveći pritisak tokom krize koju izaziva pandemija korona virusa. Rad predstavlja analizu uticaja kovida 19 na tematske turističke rute. Naglasak je stavljen na istraživanje uticaja pandemije na tržišnu strukturu i sezonalnost, kao eksterne dimenzije, kao i na zapošljavanje i mere kontrole troškova, instrumente unutrašnje dimenzije upravljanja. Analiza studije slučaja zasnovana je na empirijskim primerima panevropskih tematskih ruta pod nazivom „Rimski carevi i Dunavski put vina" (RER & DWR) i „Via Dinarica Route" (VDR). Rad takođe nudi modele različitih scenarija za oporavak biznisa i dalji razvoj. Nalazi pokazuju da je kovid 19 imao minimalan uticaj od -2% na zapošljavanje na tematskim putevima, a da su značajne kontrolne mere troškova dominantno usmerene ka fiksnim operativnim troškovima. Tematske rute su zabeležile smanjenje operativnog vremena poslovanja do 50%, a istovremeno su doživele restrukturiranje tržišta, pri čemu su domaći i regionalni gosti postali vodeći segmenti. Analiza pokazuje i da je najpotrebniji vid podrške koju vlada pruža kroz mere ublažavanja krize podrška unapređenju destinacija, kao i podrška platama i smanjenje troškova komunalnih usluga.

Ključne reči: *kovid 19, tematske rute, kulturne rute, turizam, performanse.*

Overview of the pandemic's impact on tourism

The rapid development of modern medicine has been the hallmark of the previous century. Despite these achievements, since the beginning of the 21st century, the world has been hit by several epidemics and pandemics. Previous research has shown that pandemics negatively influence the tourism and hospitality sectors [23], [24]. Pandemics have particular negative economic impacts on tourism [20], such as those caused by the 2002 SARS pandemic [18], [36], [63], the 2009 swine flu pandemic [47], [56], the 2013 Ebola epidemic [44], the 2015 Zika virus epidemic [73], and, finally, the 2019 coronavirus disease (COVID-19) pandemic, which is still ongoing and whose definite impact cannot be measured at present.

Following the reports of the first pneumonia cases of unidentified origins in China in December 2019, the COVID-19 crisis spread worldwide almost immediately. Accordingly, the World Health Organization proclaimed a global pandemic on January 30 2020 [22]. In the meantime, the COVID-19 crisis has demonstrated that tourism and hospitality are seen as secondary and are extremely sensitive to external shocks [9]. Additionally, "the indirect effects of COVID-19 are likely to be considerably higher than with SARS" [66, p. 2], since medical and health crises have a more significant negative impact on tourism than outbreaks caused by economic and financial issues [72], or even by terrorism [44].

The COVID-19 crisis also challenged the neoliberalism approach, whose main characteristic was reducing the government's role [25], given that governmental (state-driven) authorities have proven to be much more effective in securing the necessary life and economic necessities during the COVID-19 period [43]. However, "the question here is if global and national authorities recognized the shocking effect on tourism and if the defined measures will support the survival of the tourism and hospitality sector" [32]. The most noticeable impact of the pandemic on the liberal market could be observed through changes (interruptions) in global and local supply chains, shifts in consumer behaviour caused by fear and panic, and the forced adjustment on the side of producers, service providers, and retailers [50]. Various forms, sizes, and impacts of government interventions in different countries have been recorded [61]. The COVID-19 intervention actions, such as lockdowns and the postponement of events, have affected travelling heavily, and the tourism industry has been confronted with a shift from "over-tourism" [28], [60] to "non-tourism" [23, p. 2]. Recent research [74] estimates that the economic impact of COVID-19 on tourism will be up to five times greater than that of the 2008 global economic crisis. Therefore, national economies are introducing tourism recovery measures, as the importance of the tourism sector for national GDP and service exports directly correlates to the amount and forms of measures implemented [30]. Sustainability has been highlighted as the most crucial approach to reviving tourism [23]. However, a national crisis management plan has been more of an exception, for instance, in Australia [52] and the United Kingdom [4], than a standard in virtually all tourist destinations. Correspondingly, the focus of academic research in the field of crisis and disaster management in tourism "is dominantly focused on the marketing and promotional aspects rather than on the other important aspects of recovery for the destination as a whole" [59, p. 22]. This includes internal factors, such as economic effects, contingency plans, sustainability, and/or recovery measures.

Understanding the framework of the cultural and natural thematic routes

Thematic routes are mostly based on cultural and natural heritage [53] and connect natural and man-made tourism resources [40]. In most cases, the thematic routes cross over to more than one country, stimulating curiosity to discover new experiences while satisfying the need for travel. Therefore, thematic routes are seen as a platform for regional tourism and economic development [33], and by crossing neighbouring regions, routes become pillars of international tourism products [70] and joint destination products.

As a critical determinant of destinations [19], cultural factors strongly influence international tourism [76]. Cultural tourism is best communicated through the development of routes that can be based on various cultural foundations [58] – such as cultural heritage [34] or wine brands [37] –

and are a form of thematic routes. Cultural routes are the bond between tangible and intangible resources, which are used to attract the current generations of "new tourism" consumers known as "creative tourism" consumers [31], incorporating into cultural tourism "more experiential and creative forms of tourism" [64, p. 109]. These routes provide exciting cultural experiences to travellers while visiting route highlights [75]. Cultural tourism experience is determined by social interaction, authentic local clues, local lifestyles, services, culture/heritage, and challenges [8, p. 8]. Numerous cultural routes, such as networks of interlinked sites [65], have recently been growing, and in Europe, many have been formed through public-private partnerships [68]. Cultural routes interlink historical and natural features [57], creating a unique combination of cultural and natural thematic routes.

COVID-19 impact on cultural and natural thematic routes

Thematic routes communicate with the market under specific brands and have been managed through a specific mechanism. Consequently, the COVID-19 lockdown has led to a shift to digital consumption of indoor cultural entities and thus to decreasing demand for these kinds of cultural institutions, putting them in financial crisis, insolvency, and furloughs of employees [62]. In contrast, it has opened up new development possibilities for outdoor cultural institutions and natural sites. Research [26], [41], [67] also show that numerous indoor museums will not survive this challenge. The question of a "new normal" experience along the cultural tourism routes raises more philosophical questions since "branding and consuming cultural heritage is an expression of nostalgia for an idyllic and idealized pre-modernity" [62, p. 7]. Nevertheless, nature-based and outer joint heritage sites, especially along natural thematic routes, experience less negative economic consequences because of the decreasing social distancing limitations. As a result, the statistics in this sector show a smaller decrease in the number of visitors [27], again acting as an inevitable part of the sustainable development of non-urban areas [35]. Moreover, the pandemic situation affected routes of business management models to the extent that it may even alter current organizational structures and polarise professionals' abilities to operate in a crisis context [2, p. 255]. Even though the COVID-19 crisis is still present, earlier research [5] proves that route attractions, such as cultural and historical sites and museums, need to secure comparable economic metrics during crisis periods and survival of the new business models; at the same time, it demonstrated the need to apply a social return on investment analysis to show broader social importance for the local, regional, and national communities.

The COVID-19 crisis also tests the pillars of globalized cultural consumption, causes a drop in the global tourism system, and influences the shift from international to local offers and demands [54] and regional tourism. Regional tourism offers become more significant because of COVID-19, where regional networks of entities on Pan-European levels, such as the European cultural routes, provide great business platforms for participants in terms of economic sustainability, tourism brand, and visibility. At the same time, tourist destinations should focus on developing domestic tourism products [30] and, together with regional tourism initiatives, use them in the recovery phase. COVID-19 has also tackled overcrowding at cultural sites, creating an opportunity for a sustainable approach. Neuts and Nijikamp [42] noticed that many cultural sites faced many visitors and that over one-third of locals in Europe found that tourists negatively impact cultural heritage sites. Cultural routes, which are the most dominant form of thematic routes, have experienced a significant drop in demand during the COVID-19 period regarding specific categories of tourists – e.g., young travellers, with a decrease of 70% – despite the expected demand resilience of demand in this segment.

Research questions

This paper presents an analysis of the selected cases to understand the COVID-19 impact on the internal management (employment and cost control measures), external management (seasonality and market restructuring), and prospect aspects (sentiments) of cultural and natural thematic routes.

The impact of COVID-19 on employment in tourism is evident [16], and the sector is experiencing higher furloughs and unemployment [29]. Since tourism generates 10% of global employment, most global and national COVID-19 mitigation measures put employees first. Therefore, this paper aims to convey an understanding of the impact on employment in thematic routes. This led to the first research question (Q1): How did COVID-19 influence employment in thematic routes?

Additionally, because of lockdowns and similar crisis mitigation measures, it is evident that tourism stakeholders should focus more on cost control measures since costs in tourism are highly sensitive to external volatilities [17]. Therefore, cost control measures, developed by using previously published articles regarding the COVID-19 impact, were also included in the analysis. Q2: How does COVID-19 influence the cost management of thematic routes?

A disproportion of tourist travelling, known as seasonality [1], was affected by COVID-19, considering that the lockdown and travel bans strongly affected the mid summer and winter seasons, leading to a 70% decrease [69]. Tourism seasonality for cultural destinations, including cultural routes, is different from that of traditional seaside destinations [14], and patterns of seasonality in cultural destinations are mainly driven by non-climatic and institutional factors (i.e., cultural festivals) [55]. Since seasonality is a time aspect of tourism performance [71] and challenges are handled by introducing new tourism products and services [19], this was also part of the case analysis in this paper. Q3: How does COVID-19 influence seasonality in the thematic routes?

International travel restrictions due to COVID-19 impacted market restructuring, and as noted before, tourist destinations started developing domestic tourism products [30]. It is due to the fact that domestic travellers and tourist movements are taking a leading position in global tourism recovery, with a market share of 75% in the total tourism economy on average [45]. Therefore, Q4 is defined as follows: How do COVID-19 influence market restructuring and shift from international to domestic and regional tourists in the thematic routes?

Prospects and scenarios are also significant. Therefore, the timing of recovery and three scenarios were suggested [46], according to which international tourist arrivals started to recover in July, September, and then December, with rates of 60%, 75%, and 80%, respectively, compared to the previous year. Subsequently, Q5 is: How do thematic routes stakeholders perceive current and future situations and match the global predictions?

The first step was to identify (map) the routes stakeholders (i.e., involved entities and institutions) [15], since "the nature and degree of crises-led transformations due to COVID-19 depend on whether and how these stakeholders are affected" [61, p. 313].

Description of the case study

The most important Pan-European network was developed through the "cultural routes" of the Council of Europe (CoE). These thematic routes aim to communicate how various countries' cultural heritage on European soil contributes to a shared and living cultural heritage [11], testifying the distinct role of thematic routes in global tourism today [40]. As a genuine transnational tourism product, the Pan-European thematic routes add value through experience diversification [13].

The CoE [12] reported that 40 thematic routes passed the certification process since first introduced in 2010, including various topics, periods, and brands. The following methodological elements are considered during the certification process [13]: socioeconomic sustainability, nature sustainability, tourism commercialization, heritage restoration, awareness of heritage, and the level of quality of the interlink between natural and historical heritage sites. Based on this methodology, two Pan-European thematic routes were selected for the case study to analyze the COVID-19 impact. The selected routes were the "Roman Emperors & Danube Wine Route" (RER & DWR) and the "Via Dinarica Route" (VDR). Based on the authors' research, it is essential to emphasize that: 1) the selected routes meet CoE-defined methodological criteria (with RER & DWR being certified in 2015 and recertified in 2019 by CoE), and 2) both routes are part of previous academic research. While the RER & DWR is an example of a cultural thematic route, the VDR is based on interlinking nature and local heritage and is a natural thematic route.

The RER & DWR is inspired by the Roman Empire and wine-growing cultures along the Danube River (at present). It covers areas along the Danube, Moesia Superior, and Moesia Inferior and regions along the Adriatic Sea, called Illyricum (historically observed around 100 AD) [49]. It is a transnational product covering numerous heritage sites, including wine regions, thus creating a network around small and medium enterprises (SMEs), local authorities, and public cultural institutions [13]. The route passes through eight European countries: Hungary, Croatia, Serbia, Bulgaria, Romania, Albania, Montenegro, and Bosnia and Herzegovina. It is a network of sub-destinations created around individual archaeological sites, locations, nature-based points, places, and buildings, monuments to the leadership of the Roman emperors in Late Antiquity. It covers the following sub-themes: Sites with Direct Connections with Emperors, Sites Connected with Military Campaigning by an Emperor, Sites Resulting from an Emperor's Military Policy, Sites Resulting from Emperors' Political Policy, and the Danube Wine Regions.

The VDR is also an international thematic route based on attractive natural resources [39]. Although the focus is on validating nature and local heritage along the Dinaric Alps, this thematic route meets the CoE criteria regarding socioeconomic and natural sustainability, tourism commercialization, and the need for high-quality interlinks between natural sites. The route creates a network of key stakeholders [51] and destination developers [38]. The VDR has been developed for specific categories of tourists, but at the same time, by following CoE criteria, it is a platform for the sustainable local economic development of the Pan-European regions that it traverses [6]. It is a megatrail that extends from Albania to Slovenia and combines a white, blue, and green trail that is connected to Albania, Bosnia and Herzegovina, Kosovo*, North Macedonia, Serbia, Montenegro, Croatia, and Slovenia, covering sub-destinations that follow the natural flow of the Dinaric Alps and the Adriatic coastline. A modern visitor combines a stay in an untouched natural environment – as offered by this route – with modern technology, expecting a complete experience from GPS navigation, smartphones for photography, and communication to create as rich an experience as possible.

When developing the RER & DWR and VDR, the first step was to define the key thematic route pillars; notably, a valid reason for their development, clear vision, market potential, and inventory of cultural assets [15], [21]. Additionally, one of the most important indicators of the socioeconomic sustainability of thematic routes is establishing route and site management through formal managerial institutions [7]. Accordingly, the RER & DWR and VDR meet these criteria. Certainly, the overall success of the routes depends on the level and quality of cooperation among different stakeholders along the route itinerary [15]. In contrast, professionals working along the route should be educated and trained [48], which is why the identified stakeholders along the RER & DWR and VDR were part of the research process.

A questionnaire was distributed in two ways: two-thirds of the respondents were from the RER & DWR, while the rest were engaged in the VDR. An electronic questionnaire was sent to the route stakeholders and to the management authorities of the routes. This was followed by in-depth personal interviews (via Zoom) only with route management authorities to understand their perspectives better and fill in gaps in the information provided through the questionnaires. A total of three in-depth interviews were conducted with representatives of both routes, making it 100% of transnational management authorities. For the VDR, eight completed questionnaires were returned, representing 100% of the national managerial institutions. For the RER & DWR, a total of 17 completed questionnaires were received, representing 75% of the key stakeholders' authorities. The process took place between September 15 and November 15 2020.

Analysis of the structure of the involved stakeholders along the routes shows that they are engaged in different activities. Furthermore, the majority are cultural and archaeological sites (30%), followed by national tourism offices (20%), hotel/restaurant/catering (HORECA) businesses (20%), and then local SMEs engaged in handling visitors (tour guides) (10%), non-governmental organizations (NGOs) (10%), and private-public regional development offices (10%).

From the geographic location point of view of the stakeholder analysis, although cultural and natural sites

are located outside of urban areas and in natural settings, the official headquarters of the stakeholders along the researched routes are mostly (52%) based in national capitals and large cities (e.g., Bucharest, Belgrade). The rest are based in smaller towns (e.g., Butrint, Albania) and cultural sites (e.g., Stobi, North Macedonia). Most of the cultural institutions are established and run as state institutions, working under the auspices of ministries, and have been operating for more than 20 years. Conversely, some of the stakeholders, such as in the VDR, are NGOs that are just being established.

The sample structure provides different insights and perspectives, enabling a credible overview of the current situation.

Results and discussion

Impact on employment in the thematic routes

Before the COVID-19 crisis, the average number of employees in cultural route stakeholders was 19.3, but a majority (51%) of them had less than ten employees. Female employment is relatively high in cultural routes, and they can be classified as the top provider of gender equality possibilities. Also, the average number of female employees is 56%, ranging between 38% in archaeological sites and 89% in local tourism organizations. In contrast, support for youth employment is limited in the cultural routes. The average share of employees below 30 years of age in cultural routes is 23%, and 30% do not have employees younger than 30. However, one specific category of stakeholders – NGOs – attracts mostly younger employees and is an excellent example of entrepreneurship, providing a solution for youth employment by starting new businesses.

However, the COVID-19 crisis had almost no adverse effect on employment. The total number of laid-off staff was 2% in total in all the observed institutions. The institutions that experienced the dismissal of workers are archaeological sites, which indicates a particular vulnerability of cultural institutions in times of crisis. All surveyed stakeholders reported job loss in direct workers along the researched routes, with one exception: the open-air sites, which reported an increase in the number of visitors and an increase in the number of employees (66%). One of the surveyed institutions reported an expected reduction of 15% in direct workers, along with a drop in the number of businesses. Correspondingly, 30% of those surveyed reported drops between 70% and 90% in direct jobs connected with tourism. Even sharper drops, between 50% and 97%, were reported in indirect jobs by all institutions that responded to this question.

Impact on cost control measures in the thematic routes

During the COVID-19 crisis, cost control measures implemented by the stakeholders in the routes were directed towards operational fixed costs. Most frequently, it was decided in the group of so-called measures of the first choice to cut marketing and operations costs by reducing payroll expenses and by partially or fully closing capacities. It is widely accepted to express solidarity among employees by cutting payroll expenses rather than cutting the number of employees (permanent or part-time workers). Additionally, companies did not hesitate to postpone capital investments, while there was no recorded paid leave for the employees. Moreover, as expected, first ranked is the use of all forms of state aid, followed by operational adjustment by applying new hygiene standards, without which all sites are deterrent to visitors.

To conclude, solidarity with employees during COVID-19 was prioritized ahead of striving to maintain and increase the productivity and efficiency of business operations.

Impact on seasonality and market restructuring in the thematic routes

Research demonstrates that the average yearly operating period for cultural routes is not year-round but rather seasonal. Many institutions have reduced the number of working hours per month. Most businesses were open only for three months because of the lower numbers of tourists coming to the sites during the first peek of the COVID-19 pandemic in the first half of 2020. The operating period of cultural routes was shortened from six months in 2019 to up to three months in 2020.

The HORECA sector along the cultural routes took the biggest hit, while other categories of stakeholders were lacking in monitoring systems. The HORECA sector reported a sharp decrease in visitors (between 80% to 90% decrease). The drop in tourist flow also led to a reduction in revenue, where there are two groups: a larger one reporting a decline of 90% and a smaller group reporting a 20% decrease in revenue. What is particularly important is that sharp reductions in the number of visitors and revenues were reported by natural sites with more than 200,000 visitors annually and by hotels with more than 1M euros of revenue in 2019. These highly developed accommodation businesses are more sensitive because of more employees and higher fixed costs. In many cases, guests have replaced them with individual accommodation units to avoid grouping situations (dining rooms, lobbies, and so forth).

The percentage of foreign visitors dropped by 50% compared to 2019, now relying solely on visitors from the region. Other responses also point to retaining visitors from the region and domestic travellers. What was noticed in other analyses was also confirmed: tourism products related to staying in natural environments are gaining importance after the COVID-19 crisis. This group of tourism service providers is exposed to higher business risk even in normal circumstances, which provides them with a higher degree of flexibility in a crisis. However, the "strategic window" opened up due to the pandemic, and now is the opportunity for actors in the routes to use it. There are significant differences between business results. Accordingly, strategic reorientation and tactical marketing measures will gain importance in the future.

Changes in the structure of visitors' origins highlight the dramatic consequences of the impact of the pandemic. The share of visitors from distant destinations, such as from other continents, which was not significant and was being built with great efforts over a long time, is currently significantly reduced (e.g., China, the United States, South Korea). The same applies to the most dominant segment of visitors in 2019, from European countries. Europe was a key segment for all the routes, and depending on the season, tourists from European countries were the leading generators of tourism flow and international receipts. The interruption of tourist flow and turnover significantly endangered visits from other European countries and the role of the key segment was taken over by visitors from the region. Although the decline of European and distant visitors is significant, in some destinations, it was noted as exceptionally high (e.g., Butrint, Albania, had a 99% drop in European tourists). Approximately 40% of

Table 1: Cost control measures employed during the COVID-19 crisis

Measures of the first choice	Frequency	Additional measures	Frequency
Cutting marketing and promotional budget	70%	Using available government support measures	70%
Payroll cut	60%	Investment in new hygiene standards	60%
Partial closure of the capacities	50%	Cutting the operational capacities	50%
Complete closure of the capacities	40%	Renegotiate supplier agreements	30%
Postponing capital investments	40%	New strategic partnerships	20%
Reducing part-time headcount	10%	Additional employment of housekeeping staff	10%
Hiring freeze	10%	Reducing permanent headcount	10%

Source: Authors' research.

Table 2: Market restructuring – major countries of origin ranking

	2019 – Countries of origin	I-VI 2020 – Countries of origin
On the Via Dinarica Route (VDR)	Regional market: Serbia Other markets: Germany, China, the Czech Republic, Poland, Slovakia, Austria, Italy	Regional markets: Serbia, Bosnia and Herzegovina, Albania, Kosovo*, North Macedonia Other markets: China, Germany
On the Roman Emperors & Danube Wine Route (RER & DWR)	Regional markets: Serbia, North Macedonia Other markets: Italy, Germany, Poland, Russia, United Kingdom, Slovenia, Cyprus, Turkey, China, Switzerland, France, Norway	Regional markets: Serbia, Bosnia and Herzegovina, Albania, Kosovo*, North Macedonia, Montenegro, Croatia Other markets: Greece, Poland, Russia, China

Source: Authors' research.

the surveyed thematic routes reported a decline in the number of foreign visitors and the revenue generated by this segment as being over 80%. A very frequent answer from stakeholders was a "decrease of 90%; notably, in one case, even a 99% decrease in the number of visitors".

It is easy to see that the origin of tourists is shifting from distant destinations to nearer ones. Distant destinations have but disappeared, and the countries of the region are gaining importance, which a simple observation can see during the summer season.

Forecast and mitigation measures for the thematic routes

Half of the surveyed institutions forecast that the effects of the pandemic will be present for a period of 12 to 24 months. However, 40% of stakeholders in the routes predict that the impact of the pandemic will last less than a year, and half of them (20% of the surveyed sample) state that it will last three to six months. Regarding the experiences and predictions in other reports, this forecast may indicate that actors along the routes are not well prepared for the upcoming situation. The participants on the RER & DWR are particularly optimistic, predicting three to six months of COVID-19 impact. Source markets for these two partners are central European countries, and they might look like the most probable region to recover.

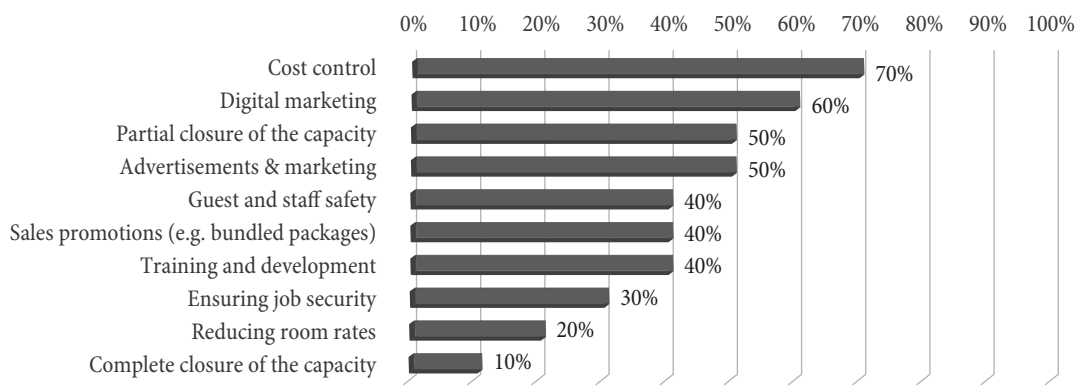
Adjusting and reducing activities and costs are more dominant than proactive marketing measures for the researched routes. Post COVID-19 measures to be implemented in the short term offer multiple choices for executive teams. A broad spectrum of measures was observed, mainly implemented by the non-business community, including museums, archaeological sites, NGOs, and similar institutions.

According to the frequency of the expected application in the conditions after the pandemic, the results show an alternation between passive measures of adjusting and reducing activities and costs to the new situation and active measures of boosting market appearance to achieve an accelerated return to the previously reached level of business. The top-ranked measure, cost control, is passive but quite understandable for times of crisis. A similar one is a third-ranked measure, i.e., partially closing the capacity.

The second-ranked measure, digital marketing, which means adapting to the contactless business conditions that consumers prefer out of fear of infection, can be assessed positively. Partial closure of capacity is predicted to be much more in use than complete closure, as well as the non-creative measure of rate (price) reductions. Forty per cent of institutions are oriented towards training and development after the COVID-19 crisis, which is undoubtedly a constructive activity. What is surprising is that all stakeholders from the VDR, a route where activities are performed in a natural environment, are planning a partial or complete closure of their capacities.

According to the stakeholders along the routes, the most needed government aid is destination promotion support. It is recommendable for the actors along the thematic routes to ask their governments for an active measure of support in marketing, precisely, as it is justified

Figure 1: Post COVID-19 recovery measures



Source: Authors' research.

even in stable business conditions. Then, other anti-crisis measures are expected - tax rebates, loan moratoriums, and employee provident fund support.

The lower-ranked measures are wage support (40%), utility costs reduction (30%), and lower interest rates (20%). Notably, some of these measures were top-priority measures, considering the activities of regional governments. Specifically, wage support, employees provident fund support, loan moratoriums, and tax rebates were implemented by five out of six surveyed governments. Although participants' gratitude for government measures is generally present, there is a noticeable difference in the ranking of the desirability of measures by market participants and the frequency of the application of measures in regional economies.

Government support will be needed, starting from the beginning of the COVID-19 crisis – either in the long or short run – to overcome the current problems. Half of the surveyed sample expected government measures to last more than one year, and out of those, 10% considered that support would be needed for more than two years. Nonetheless, half of the sample considered that support would be necessary for up to 12 months. In this group, 30% expected measures to last 10 to 12 months, while 10% expected to support at least half a year and 10% for just one quarter of the year. Hoteliers expected long-range support for more than one year. These findings are broadly in line with small and medium enterprises [3], [77].

Conclusion

Thematic routes, as a tourism product that emphasizes the joint cultural and natural heritage of Europe, face substantial challenges due to the COVID-19 crisis. The anticipated operating months of the routes were reduced, with only one-third expecting to operate for only three months. This affected their business performance because of a lack of international tourists and decreased international receipts, but visitor demographics have dramatically shifted to the local and neighbouring markets. Archaeological sites showed a particular vulnerability to reduced tourism flows and experienced the most significant employee reductions. In cases where experience is based on open-space sites, increases in revenues and visitors were recorded, showing that the concepts of open-air museums and sites were essential. Cost control measures have widely prioritized protecting workers at the expense of other operational costs. Route stakeholders prefer support going forward, such as destination promotions, demonstrating a positive approach to recovery.

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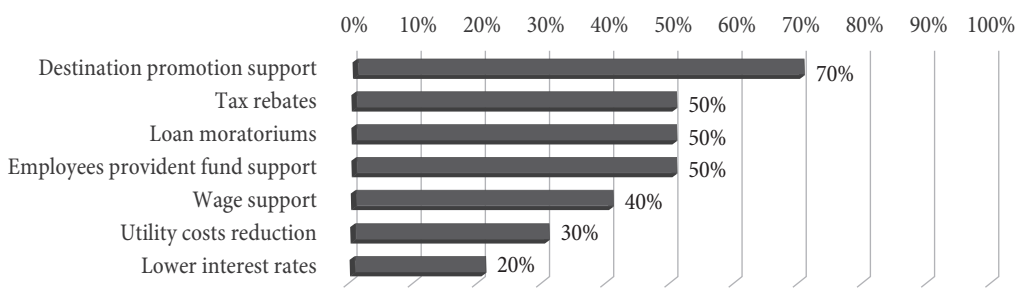
Figure 2: Post COVID-19 most preferred support



Source: Authors' research.

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PROTECTION OF RIGHTS OF SECURED CREDITORS IN THE BANKRUPTCY DEBTOR ASSETS SALES PROCEDURE

Zaštita prava obezbeđenih poverilaca u postupku prodaje imovine stečajnog dužnika

Abstract

Securing claims by way of real assets such as mortgage or chattel mortgage has great significance for the operation of banks and other economic entities. Opening bankruptcy proceedings over the owner of the real estate under mortgage or movable property under chattel mortgage has a significant impact on the process of exercising rights and the position of secured creditors. Bankruptcy framework in the Republic of Serbia limits their rights on the one hand, and provides extensive guarantees, on the other, by prescribing several specific institutes that additionally protect the rights of secured creditors in the procedures of bankruptcy debtor asset sales, which is the topic of this paper.

Provisions of the Law have been analyzed, positions of the judicial practice as well as opinions of the jurisprudence on secured creditors as a special category. Special attention was paid to the impact of the legal prohibition of individual enforcement for the settlement of claims from the assets that are under any burdens as well as the cancellation of moratorium. Significance of the right of the creditor to offset its secured claim against purchase price has been explained in detail in case of the best bidder (credit bidding) as well as the legal preemptive right on the subject of secured right or lien, in case of sales method by direct agreement. Also, rules were considered that condition the possibility of leasing assets under burden of the bankruptcy debtor with the consent of secured creditors.

Keywords: *bankruptcy, secured creditor, moratorium, credit bidding, preemptive right, lease.*

Sažetak

Obezbeđenje potraživanja realnim sredstvima kao što su hipoteka ili ručna zaloga ima veliki značaj u poslovanju banaka i drugih privrednih subjekata. Otvaranje stečajnog postupka nad vlasnikom hipotekovane nepokretnosti ili založene pokretne stvari, bitno utiče na postupak ostvarivanja prava i položaj obezbeđenih poverilaca. Stečajni okvir u Republici Srbiji s jedne strane ograničava njihova prava, a s druge strane pruža značajne garancije, propisivanjem više specifičnih instituta kojima se dodatno štite prava obezbeđenih poverilaca u postupku prodaje imovine stečajnog dužnika, što je tema ovog rada.

Analizirane su zakonske odredbe, stavovi sudske prakse, kao i mišljenja pravne nauke o razlučnim i založnim poveriocima, kao dve posebne kategorije obezbeđenih poverilaca. Naročita pažnja usmerena je na uticaj zakonske zabrane individualnog izvršenja na namirenje potraživanja iz opterećene imovine, kao i na ukidanje moratorijuma. Detaljno je objašnjen značaj prava poverioca da prebije svoje obezbeđeno potraživanje sa kupoprodajnom cenom, za slučaj da je on najbolji ponudilac (credit bidding), kao i zakonsko pravo preče kupovine na predmetu razlučnog, odnosno založnog prava, u slučaju metoda prodaje neposrednom pogodbom. Takođe, razmotrena su pravila koja mogućnost izdavanja u zakup opterećene imovine stečajnog dužnika uslovljavaju saglasnošću razlučnih, odnosno založnih poverilaca.

Ključne reči: *stečaj, obezbeđeni poverilac, moratorijum, credit bidding, pravo preče kupovine, zakup.*

Introduction

Bankruptcy proceedings in the Republic of Serbia have been prescribed by the Law on Bankruptcy [50] and are initiated by the petition of the creditor, debtor or liquidator as authorized petitioners (Article 55, paragraph 1). Adopting positive decision on such petition, in case the court determines the existence of one of prescribed legal bankruptcy conditions represents the opening of the bankruptcy proceedings [10, pp. 87-88]. Bankruptcy judge shall open bankruptcy proceedings by adopting a decree on opening bankruptcy proceedings that adopts the petition for initiating bankruptcy proceedings (Article 69, paragraph 1). All legal consequences of bankruptcy, including the prohibition of enforcement and settlement – moratorium shall come into effect by way of opening bankruptcy proceedings, and not by the initiation of proceedings by submitting the initial act – petition of authorized persons [11, p. 84]. The moratorium shall entail the prohibition of implementation of individual enforcement over the property of the bankruptcy debtor for the purpose of the settlement of claims of individual creditors and shall commence as a process and legal consequence on the date of opening bankruptcy proceedings or as an option – in case the court, in the prior bankruptcy proceedings, determines the security measure that contains the same prohibition that refers to the exercise of rights of secured creditors [12, p. 920]. Security measures (Article 62, paragraph 2, item 4) and moratorium (Article 93, paragraph 1) may be cancelled under the same conditions regulated by the provision of Article 93a and 93b [36, pp. 108-109]. The moratorium delays the deadline for debt payment by law [47, p. 585] to a certain phase of bankruptcy proceedings – the validity of the decision on the main distribution of bankruptcy estate (Article 143, paragraph 1), that is, until the sales of assets under burden in case of secured creditors. Satisfaction of secured creditors must be performed within five days from the date the bankruptcy administrator received the funds from sales of property, that is, the collection of claims (Article 133, paragraph 12), where the bankruptcy administrator shall be obligated to offer for sales each item of property that is subject to secured right or lien within six months from the validity of the decision on bankruptcy (Article 133a). The share of settlement of secured creditors is approximately 70% from assets remaining after the settlement of costs and liabilities of the bankruptcy estate [15, p. 105], and they do not have the right to claim default interest due to delay of the bankruptcy administrator in settlement [36, p. 196].

Legal consequences of opening bankruptcy proceedings over the owner of real estate under mortgage or movables under chattel mortgage, and primarily the moratorium, have a significant impact on the procedure of exercise of rights and position of secured creditors, regardless of the fact they do not lead to the cessation of real securities since, as a rule, they disable the implementation of proceedings of individual enforcement and settlement outside bankruptcy proceedings, thus limiting their rights.

The mortgage loses the property of adequate collateral if the owner of the real estate under mortgage is in bankruptcy, which leads to the classification of claims of the bank from debtors into the least favorable category D [29] and to the increase of the amount of required provisioning for estimates loss as per assets from balance sheet and off-balance items representing deduction from the basic share capital [30] with adverse effect on the bank's capital adequacy.

Therefore, it is necessary to provide additional protection of rights to this category of creditors in the procedure of bankruptcy debtor assets sale.

For this purpose, having in mind the significance of real securities, such as mortgage or chattel mortgage in the operations of banks and other economic entities, the bankruptcy framework of the Republic of Serbia prescribes several specific institutes that establish a special mechanism for protection and exercise of secured creditor's rights. The value of lien lies in the fact that it provides the secured creditor with the option of settlement even when other creditors cannot be satisfied in full or at all, since the debtor does not hold sufficient assets to meet all the obligations [42, p. 35].

After the clarification of the legal position of secured creditors and the effect of moratorium, the most significant institutes and procedures have been reviewed that enable secured creditors to implement lien in bankruptcy proceedings from the value of assets under burden.

Separate creditors and pledge creditors as two categories of secured creditors

Law on Bankruptcy differs separate and pledge creditors as two categories of secured creditors. The criteria for differentiation are whether the creditor has or does not have claims that are secured by mortgage or pledge over the assets of the bankruptcy debtor, that is, whether the bankruptcy debtor is simultaneously the debtor of the secured claim or it is a third party.

Our bankruptcy law recognizes specially regulated situations when the owner of the movable under pledge or real estate under mortgage (pledge or mortgage debtor) [49, p. 20] and the debtor from the original transaction are not the same person, thus, the bankruptcy is initiated over the owner of assets, towards which the creditor has no claim from the original transaction. For example, from loan agreements, since this person established pledge or mortgage over its own property for securing creditor's claim towards a third party – loan beneficiary. Such situations caused a number of issues and different interpretations in earlier court practice that were mostly removed by legal novelty from 2004 [51], by prescribing certain rules based on positions and solutions reached by court practice.

Separate creditor has claims towards the bankruptcy debtor that are secured by mortgage or pledge over the property of the bankruptcy debtor (lien) or legal right of retention or right to settle over items and rights registered in public books or registries and shall be entitled to a priority settlement from funds received from the sales of assets, that is, the collection of claims that form the basis of such right [2, pp. 205-221]. "One should keep in mind that the separate creditor shall be entitled to priority collection only from certain items owned by the bankruptcy debtor, subject to lien or settlement right. There is no general lien over the entire property of the debtor and all income of the debtor that would weaken the position of the debtor" [22, p. 81].

When the litigation for the purpose of determination of the amount of secured right is ongoing, and the assets under burden are sold before the valid finalization of the litigation, it would be prudent for the bankruptcy administrator to pay to the separate creditor "the undisputed portion of claims secured by the right to priority in settlement" [36, p. 164]. "Existence of dispute regarding the order of settlement of separate creditors shall not affect the right of the buyer to register ownership right and erase the burden. The amount of available funds for the settlement of separate creditors shall remain the same in case of dispute on the order of settlement of separate creditors and in situations where there is no dispute on the order of settlement of separate creditors" [36, pp. 195-196].

On the other hand, pledge creditor has real estate collateral over the assets of the bankruptcy debtor (lien over items or rights of the bankruptcy debtor that are registered in public books or registries) but has no monetary claim towards the bankruptcy debtor that is secured by such lien. In legal theory such persons are named "pledge creditors with claims towards third parties" [38, p. 249]. Pledge creditors are not bankruptcy creditors and are not separate creditors, and they shall be settled in the maximum amount received from cashing in assets being subject to lien. Therefore, pledge creditors have the main claim towards third parties [43, p. 205], with the pledge over the property of the bankruptcy debtor as their own collateral.

"If a third party disputes the status of the pledge creditor and the pledge is registered in public books or registries, the third party may dispute the validity of the pledge instrument only in litigation. The bankruptcy judge may not decide on the nullity of the pledge statement. If the bankruptcy administrator or a third party disputes the validity of the pledge statement, the civil court shall adopt a decision on such matter" [37, pp. 128-129]. "If the bankruptcy administrator considers the lien non-existent, and it is a right registered in public books or registries, litigation shall be initiated seeking to determine the non-existence of such lien including the litigation for rebuttal of transactions" [36, p. 160]. It is a negative determination suit.

Establishment of mortgage over the real estate of bankruptcy debtor for the benefit of pledge creditors, for securing obligations of other persons, for example, claims of the bank towards third parties, has been qualified in court practice as unencumbered disposal, because the "pledger did not receive adequate counter-value" and

"pledger may not request any counter-act by a person benefiting from such disposal", "even though there was no legal obligation for such disposal" [36, p. 171], which represents the act of causing intentional damage to the creditor that may be rebutted if taken in the last five years prior to the submission of petition for bankruptcy, in which case there is a rebuttable legal presumption that the pledge creditor had knowledge about the intention to damage other creditors (Article 123, paragraph 1).

Pledge creditors are recognized as parties in bankruptcy proceedings which was disputed in earlier court practice in a certain number of cases, with the argumentation that they have no claims towards the bankruptcy debtor. But the pledge creditors are not entitled to vote in the creditor's assembly that is, "they may not vote or be elected in the creditor's assembly and committee" (Article 49, paragraph 7) while separate creditors may participate in the creditor's assembly only to the extent of their claims for which they are likely to appear as bankruptcy creditors (Article 35, paragraph 3), where at the first creditor's hearing separate creditors chose one member of the creditor's committee from their ranks (Article 38a, paragraph 1).

If the transfer of secured claim is executed during the bankruptcy proceedings (Article 117a), upon the submission of the request for correction of the final list of determined claims, the recipient shall be enabled to exercise the right of assignee – prior separate creditor, as the party in bankruptcy proceedings. Even though the novation from 2017 [52] cancelled the limitation related to the stage of bankruptcy proceedings in which transfer of claims is possible [15, p. 336], jurisprudence mainly implements interpretation that "submission of this request during bankruptcy proceedings for the acquirer is enabled until the validity of the decision on main distribution, after which time the transfer of claims in bankruptcy is not possible" [43, p. 208].

Other property rights at disposal of their owner may be subjected to lien. Provisions on the pledge on items may be applied to pledge on claims and other rights, unless prescribed otherwise [34, pp. 491-507]. Bankruptcy debtor has procedural standing to seek the collection of claims and litigate against the debtor of claim under pledge, after which, from the funds received, separate creditors shall be paid out that have collaterals over the claim of the bankruptcy debtor towards his debtor. Secured right should be recognized conditionally since the settlement of the separate creditor depends on the fact whether the bankruptcy debtor will succeed in collecting his claims [36, pp. 126-127].

Also, the subject of lien may be the right of claim of the pledger towards the debtor in the case where the pledge creditor is the debtor of pledger, except for claims whose transfer is prohibited by law and those related to an individual person that may not be assigned to others [53]. In this way, through the implementation of the pledged claim, in case the pledge creditor is the debtor of the pledger at the same time, a compensation is possible – offsetting of mutual, similar and due claims [48, p. 472] as one of the legally prescribed methods to cease the obligation.

Moratorium – legal prohibition of individual enforcement over the assets of the bankruptcy debtor

Initiating bankruptcy proceedings over the owner of real estate under mortgage or movables under pledge leads to important changes in the position and rights of secured creditors, regardless of the fact that it will not lead to the cessation of real estate collaterals. Because, by initiating bankruptcy proceedings, significant substantive legal consequences shall occur for the bankruptcy debtor and its assets, claims of creditors and transactions. Also, there are procedural legal consequences in proceedings the debtor is part of [39, p. 603] that lead to the mandatory cancellation of all court and administrative proceedings as well as the establishment of legal prohibition of enforcement and settlement against the bankruptcy debtor, that is, over its assets.

Monetary claim shall be collected in the procedure of individual or general enforcement [35, p. 436]. Individual enforcement shall be executed in the enforcement proceedings, while general enforcement shall be executed in the bankruptcy proceedings. The principle first in time, greater in right *(prior tempore potior iure)* is valid in the enforcement proceedings, while in the bankruptcy proceedings the creditors are settled at the same time and

concurrently [40, p. 404], implementing one of the main principles of bankruptcy – equal treatment of creditors *(par conditio creditorum)* [41]. Bankruptcy is an institute of simultaneous collective and proportional settlement of all creditors through general enforcement on the entire assets of the bankruptcy debtor, by which such debtor ceases to exist as a legal entity [46, p. 325]. In a situation where the assets of the debtor are so depreciated that the liabilities are higher than assets, conditions for settlement in bankruptcy proceedings arise, thus the principle of collective enforcement over the entire assets of the insolvent economic entity for joint and proportional settlement of creditors derogates the principle of priority of collection that is valid for enforcement proceedings, as the process for individual settlement. Bankruptcy proceedings enable joint and proportional settlement of creditors [3, p. 3]. This means that these two proceedings are mutually exclusive.

This is why one of the procedural legal consequences of initiating bankruptcy proceedings is the established prohibition of individual enforcement and settlement of creditors that leads to the inability of enforcement over the assets of the bankruptcy debtor and mandatory interruption of enforcement (Article 93), thus making court decisions and other enforcement documents lose their property of enforceability, but not the property of validity [16, p. 74]. The term "moratorium" in jurisprudence [28, p. 36] as well as court practice [36, pp. 108-109] is used to signify the prohibition of settlement and enforcement as legal consequences of initiating bankruptcy proceedings. The moratorium protects the bankruptcy debtor by providing it with the option to consolidate before the creditors start collecting their claims and by allowing the bankruptcy administrator to prepare the sales of debtor's assets when the proceedings are forwarding in the direction of bankruptcy [4, p. 66]. Thus, the losses arising from bankruptcy for the creditors are evenly distributed among them if collected in the same payment lines [4, p. 64]. Prohibition to initiate, that is, the cancellation of enforcement proceedings has been established since the enforcement would favor only those creditors with an enforcement document [9, pp. 70-71].

Moratorium shall not be valid for enforcement that refers to the obligations of the bankruptcy estate and costs of the bankruptcy proceedings, that is, obligations incurred during the bankruptcy proceedings. Obligations arising during the proceedings shall be considered costs of bankruptcy proceedings, which are settled regularly and as priority, prior to the claims of creditors classified into payment lines, thus, their enforcement is possible [21, p. 151].

Hence, the bankruptcy proceedings have priority in execution over the enforcement if the debtor is subjected to both at the same time. Therefore, the enforcement, which is ongoing at the moment of initiating bankruptcy proceedings, shall be cancelled *ex officio* except in special cases when it entails a timely acquired right for separate settlement [44, p. 112]. Procedure legal consequence of the prohibition of enforcement and settlement against the bankruptcy debtor, that is, its assets, has been established with the purpose of not interfering with the even settlement of all creditors [23, p. 148], accomplishing the basic principle of protection of bankruptcy creditors enabling collective and proportional settlement of bankruptcy creditors (Article 3).

Prohibition of enforcement and settlement that occurs *ex lege,* as a consequence of initiating bankruptcy proceedings, shall primarily refer to ordinary – bankruptcy creditors, that is, persons that have unsecured claims towards the bankruptcy debtor on the day of initiating bankruptcy proceedings (Article 48) and to the exercise of rights of secured – separate and pledge, creditors, as two categories of secured creditors.

By initiating bankruptcy proceedings, the secured right is exercised only in bankruptcy proceedings, except in case of the adoption of a decision on cancellation of the prohibition of enforcement and settlement in line with the Law on Bankruptcy (Article 80, paragraph 2) [12, pp. 919-942].

Possibility of cancellation of the legal prohibition of enforcement and settlement at the proposal of secured creditor

Secured creditors may propose cancellation of the prohibition of enforcement and settlement for the purpose of collecting secured claim from the pledged assets of the

bankruptcy debtor, which is subject to a court decision. In case the conditions for moratorium cancellation are met, the secured creditors shall implement the settlement procedure individually and outside the bankruptcy proceedings, in line with general rules on settlement out of court or in court, therefore, in the same manner as if the bankruptcy debtor was not bankrupt [13, pp. 515-529]. Non-performing loan market is incentivized by enabling the secured creditors to individually implement claim collection procedures.

The novelty from 2017 [52] modified three former reasons for moratorium cancellation, and provisions that regulate them are distributed into new Articles 93a and 93b, while Article 93c contains mutual provisions for cancellation of security measures, that is, the prohibition of enforcement and settlement, and Article 93d regulates the consequences of failure to cash in property by secured creditors in a legally prescribed deadline.

The Law prescribes the duty of securing an adequate protection of assets and, as the reasons to cancel moratorium, prescribes the failure to adequately protect the assets or the depreciation of assets that are being secured (Article 93a). The possibility of cancelling moratorium related to the assets being subject of collateral has also been regulated, which is not of key importance for reorganization or the sale of bankruptcy debtor as a legal entity [24, p. 35] for the period of nine months, provided that the claim of the secured creditor is due in part or in whole and if the value of the asset in question is lower than the amount of secured claim (Article 93b).

"Creditors prove the acquisition of status of bankruptcy, i.e. separate creditors by adopting the final list of claims by the bankruptcy judge, in case their claims are determined, and in case they are disputed, by the adoption of the valid court decision based on which they can seek correction of the final list… Moratorium cancellation may be requested only after the adoption of the final list of claims, that is, conclusion on the list of determined and disputed claims." [36, pp. 136-137]

A new model of secured creditors settlement was introduced (Article 93a-93e), improving the mechanism of the bankruptcy debtor's assets cashing in. Secured creditors have an option to individually implement the procedure of individual settlement of their own claims from the assets in their pledge. Considering the procedure of cashing in assets prescribed by special laws and the actions that need to be taken in this procedure and court practice, nine-month period was set during which, after the cancellation of moratorium, individual settlement of secured creditors is allowed. In case secured creditors do not execute settlement in this period, this right shall be denounced from them by the reestablishment of moratorium, except in cases of submission of the petition to extend such deadline [12, pp. 919-942].

Discretional authority of the bankruptcy judge to assess whether the assets are of key importance for reorganization or for the sale of the bankruptcy debtor as a legal entity has been cancelled, which is a condition of the decision on moratorium cancellation. It has been regulated that the judge shall not adopt any decisions on security measures cancellation, that is, the prohibition of settlement and enforcement, in case the bankruptcy administrator proves that the assets in question are of key importance for reorganization, or the sale of the bankruptcy debtor as a legal entity (Article 93b, paragraph 2). This introduced the obligation of proving the significance of property for the reorganization or the sale of bankruptcy debtor as a legal entity, and the burden of proof was transferred to the bankruptcy administrator, meaning that the law presumes the asset that is the subject of secured right or lien is not of key importance for the reorganization or sales of the bankruptcy debtor, but it allows that the bankruptcy administrator may prove otherwise (rebuttable legal presumption) [12, pp. 919-942].

The adopted new model represents the harmonization of domestic legislation with the Council Regulation (EC) No. 1346/2000 of 29 May 2000 on Insolvency Proceedings that recognizes and determines the specifics of the position of secured creditors, respecting their right to separate settlement from the value of assets under pledge [24, p. 36].

Credit bidding by separate or pledge creditor

The rules named *"Credit Bidding by Separate or Pledge Creditor"* (Article 136b) regulate the right of the secured

creditor to offset its secured claim against the purchase price in case such creditor is the best bidder *(credit bidding).*

Special rules for two possible situations have been prescribed – the first one, when the secured claim is higher than the purchase price, that is, its portion over which the right of priority is given to the secured creditor (for example, if a part of the asset is sold or the bankruptcy debtor as a legal entity, or if there are creditors with higher priority over the same real estate) and the second one, when the secured claim is lower than the purchase price, that is, its portion over which the right of priority is given to the secured creditor. In both cases the secured creditor shall be obligated to pay all expenses that have to be settled from the purchase price (appraisal, notices, legal obligations, etc. including the compensation for the bankruptcy administrator) in order to secure due collection. However, the "bankruptcy debtor shall bear all the costs of property tax over the subject of lien" [36, pp. 197-199].

Additionally, in the first case, the secured creditor as the buyer of property or of the bankruptcy debtor as a legal entity has an obligation to pay the remaining portion of the purchase price "from which there is no right of priority settlement" (therefore, the amount of difference between the portion over which the right of priority settlement exists and the total price) in order to secure the settlement of secured creditors of higher order of priority, that is, the collection of the price portion that belongs to the bankruptcy estate. Such situation occurs if, for example, on the same real estate, the separate creditor – buyer holds a mortgage of lower priority, second order mortgage, that secures its claim in the amount of EUR 100,000, and another creditor holds a first order mortgage established for securing EUR 20,000 claim, while the real estate was sold at EUR 90,000. In this situation the second creditor should settle first from the purchase price, for the entire amount of its claim, EUR 20,000, which means that the separate creditor – buyer, in addition to expenses, should pay another EUR 20,000 ("*remaining portion of the purchase price from which there is no right of priority settlement*") and would be considered settled via offsetting in the amount of approximately EUR 70,000, less sales costs, while such creditor would settle for the difference to the full amount of claim (somewhat over EUR 30,000) as a regular creditor from the third payment order [5, p. 490].

Due to the principle of indivisibility related to the subject of pledge [6, p. 139] the mortgage shall include the real estate as a whole, even in case of its division [32, p. 463], including all the improvements in value of the property under mortgage, which is a consequence of the extensivity principle [45, p. 31]. Therefore, our opinion is that in the clarification of novelties an error occurred with the clarification of this institute since the obligation of payment of price difference in case that the secure claim exceeds the amount of the purchase price has been explained with the requirement to settle the creditor of the lower priority, that is, *"to secure the settlement of secured creditors of lower priority"* [24, p. 41], which does not make sense. If the buyer of the property (separate creditor) has claim that is higher than the purchase price, that is, it "*exceeds*" the price amount, then such creditor will settle through compensation to the amount of the purchase price (reduced for any expenses). Legally, it is not possible to use the price that is not sufficient to entirely settle the secured claim of the buyer of the property for settlement of other secured creditors "*of lower priority*" but only if there are creditors of *higher priority* compared to the secured separate creditor that is the buyer of the property [17, p. 81].

Maybe the sales costs could have been distributed more fairly and maybe such costs should have been divided proportionally to all mortgage creditors, in line with the value of claims to be collected from the purchase price.

In the second case, if the secured claim is lower ("will not reach the amount of purchase price, that is, the portion over which the priority of settlement exists"), the secured creditor shall be obligated to pay the difference to the full amount of the purchase price (that is, "difference between the secured claim and the full amount of the purchase price").

Through provisions that regulate the sales procedure the separate creditor is not "released from deposit payment" that must be differentiated from the costs of sales, which are not paid, but collected primarily from the purchase price. Deposit payment is a condition for participation of the secured creditor in the sales procedure and if its bid

is the most favorable one, such creditor is pronounced the buyer and shall exercise rights from Article 136b [37, pp. 144-145]. The deposit shall be retained in case the separate creditor with the most favorable bid withdraws from the purchase.

"Bankruptcy administrator shall, in case of sales of property to the secured creditor by price bidding, prepare the settlement calculation as well as the calculation of sales costs. Creditors may object to the settlement calculation which is subject to the decision of the bankruptcy judge. Bankruptcy judge shall decide on costs, by way of special conclusion which may be subject to an appeal" [37, pp. 147-148]. Based on the rules stated, the "bankruptcy administrator shall call upon the separate or pledge creditor to execute the payment, otherwise it shall not be considered that the separate or pledge creditor met the foreseen sales terms" [37, pp. 147-148], which means that such creditor will not be announced a buyer but another most favorable participant in the asset sales process.

Application of credit bidding institute when the buyer of property under burden is the pledge creditor

Wording of Article 136b does not mention the pledge creditor even though it is stated in its headline: *"Credit Bidding by Separate or Pledge Creditor"* [5, p. 491]. Despite this omission, the *credit bidding* institute may be applied if the buyer of the property is the pledge creditor – that is, the creditor with lien over objects or rights of the bankruptcy debtor registered in public books or registries, that has no monetary claim towards the bankruptcy debtor that is secured by such lien, but towards third parties (Article 49, paras 5 and 6), since there is one basic difference between separate and pledge creditors – which is whether they have simultaneous monetary claim towards the bankruptcy debtor that is secured by mortgage or lien, over objects that are subjected to sales, or towards third parties. However, this difference does not exclude the application of the *credit bidding institute* to pledge creditors [15, pp. 448-449].

If the property buyer is an excluding creditor that has priority in settlement from the funds received through sales, such buyer would be entitled to compensate its secured monetary claim (towards a third party, not towards the bankruptcy debtor) from the amount of purchase price that is owed. Unlike general terms of compensation from the contract law, in case of application of the *credit bidding* institute the mutuality of claims of the secured creditor and the bankruptcy debtor, as the owner of the real estate under mortgage, is not a condition for compensation. Absence of mutuality, therefore, shall not prevent the compensation of the secured claim towards a third party with the price that the pledge creditor paid for the object under burden owned by the bankruptcy debtor.

Offsetting (compensation) as a basis of the credit bidding institute

Offsetting (compensation) is the basis of the institute of credit bidding by separate or pledge creditors. Jurisprudence considers compensation a form of payment [33, p. 131]. The purpose of offsetting is simplification of the procedure of fulfilment of mutual obligations with the purpose of avoiding double payments. Usually, it is a case of two monetary obligations where the compensation is an instrument of their regulation without utilization of cash [9, p. 75]. In the Serbian bankruptcy law, it is possible to compensate claims from unsecured creditors with the claims of the bankruptcy debtor under special terms (Article 82, paras 1 and 2) [14, p. 672].

Credit bidding provides the separate creditor with the right to compete in case of the sales of assets on which holds secured right and to use the amount of its claim instead of money to pay the price. In this manner separate creditors may control the sales of assets over which they hold secured rights [26] and react in case they feel the achieved price of collateral in public bidding, and their settlement, is not adequate. In other words, in case the opinion of the separate creditor is that the received price is low, such creditor may offer a higher price and after the transfer of ownership right such creditor may try to sell those assets for a higher price or retain those assets [25, pp. 111-112]. On the one hand, the outcome in case of price payment using claims or money is the same, as a rule. Let us presume that the separate creditor has a claim in the amount of one million dinars and that the assets over which secured right exists is intended for sale.

In case the received price is also one million dinars, for the purpose of simplicity of the example, and is paid in cash, the entire amount, after deduction of costs, would be used for settlement of the same separate creditor. In case the received price is "paid" using claims instead of cash, the outcome would basically be the same. The basis of this institute is, therefore, offsetting (compensation), since the separate creditor will offset its obligation to pay the purchase price against its monetary claim that is secured by mortgage over the real estate in question. The only difference is that the separate creditor bears the costs of sales in the second case. If the received price is lower than the amount of claim, the separate creditor, after paying sales costs, shall acquire the right to settle for the difference in the value of such amounts as the bankruptcy creditor. If the received price is higher than the amount of claim, the separate creditor shall only pay the difference between its own claim and the received price.

Without special provisions (Article 136b), offsetting of such claims and obligations according to general rules (Article 82) would be impossible, since they do not meet the regulated conditions, regardless of the fact that they are not explicitly included in cases when offsetting is not allowed (Article 83). As a counterargument to this position, one might state that general rules on the right to compensate claims in bankruptcy proceedings (Article 82) shall not apply to separate and excluding creditors that are entitled to priority in settlement from funds received from the sales of assets, that is, entitled to priority and separate settlement from the price received from the sales of real estate under mortgage or other assets of the bankruptcy debtor that are under lien. Therefore, a conclusion could be drawn that the application of the *credit bidding* institute was possible even before the novelty from 2017 based on general rules and principles of bankruptcy proceedings.

The institute of *credit bidding* itself is not completely new in the Serbian legislation. The Law on Enforcement and Security – LES from 2015 (Article 192, paragraph 4) prescribes the possibility of the buyer being the enforcement creditor that can participate in public bidding by offering only the difference in price between its claim and the price received, considering the priority of such creditor [18, p. 464]. Similar rule was included in the prior Law on Enforcement and Security from 2011 (Article 130, paragraph 2): "if the buyer is the enforcement creditor whose claim does not reach the amount of received price on public bidding and if, considering its priority, such creditor could settle from the price, such creditor shall pay only the difference between the claim and the price received", and also in the Law on Enforcement Procedure from 2004 (Article 128, paragraph 2). The important difference compared to bankruptcy is that in the enforcement proceedings the buyer may be not only the mortgage creditor, but also an ordinary, regular creditor, therefore, any enforcement creditor, but priority of such creditor compared to others shall be taken into account, primarily related to pledge creditors, since this is not a collective settlement, as the case is in bankruptcy, but individual enforcement and settlement of the enforcement creditor [17, p. 85].

Preemptive right of the separate or pledge creditor in case of sales through direct agreement

One of the consequences of initiating bankruptcy proceedings for the bankruptcy debtor is the termination of previously acquired preemptive rights (Article 75), both contractual and legal rights (for example, preemptive right of the co-owner of real estate or the neighboring agricultural land) [55], and simultaneous establishment of legal preemptive right for the benefit of secured creditors and their related persons on the subject of secured right or lien, in case of method of sales through direct agreement (Article 136d). "Preemptive right may be defined as the right whose holder is authorized, in case of sales of items to which the preemptive right refers to, to acquire such items prior to anyone else, through purchase in case conditions of sale are met that are determined by the owner of the item (seller)" [1, pp. 147-148]. Through the cancellation of previously acquired preemptive rights the collision with the legal preemptive right of secured – separate and pledge, creditors, over the subject of secured right or lien is avoided, that would occur had the stated consequence of bankruptcy proceedings initiation not been prescribed.

Hence, in addition to the transaction (for example, contract or last will and testament), the source of

preemptive right may be the law [33, p. 573], where the legal preemptive right is applied *erga omnes*. On the other hand, the contractual preemptive right is applied *inter partes,* thus, only related to the contracting parties (for example, seller and buyer from the contract on sales with preemptive right) and can be applied related to third parties only in case of negligence in particular case [33, p. 573].

When assets that are subject to secured right or lien are sold through direct agreement, the secured creditor may, within five days from the receipt of the notice of the bankruptcy administrator on proposed sale that must include all the terms of the sale that is proposed, including the price and payment method, notify the court and the bankruptcy administrator that it accepts to purchase the subject of sales under conditions from the notice (or more favorable conditions for the bankruptcy debtor) (preemptive right), where it must be stated whether the right (Article 136b) to compensate its secured claim with the amount of purchase price shall be exercised (*credit bidding*) [17, pp. 69-90]. This additionally protects its position in situations where there are no public announcements of the sales process (when the method of sales is not public bidding or public collection of bids), without damaging the bankruptcy estate, since such creditor, provided that it wishes to use this right, shall be obligated to offer the same terms as offered by the best bidder, at minimum.

The establishment of preemptive right for the separate creditor in case of sales through direct agreement, similar to the credit bidding, enables the separate creditor, in case that he is of the opinion that adequate price has not been received, to purchase the subject of sales under the same (or more favorable for the bankruptcy debtor) terms from the notice of the bankruptcy administrator on the proposed sales. In case the right to credit bidding is not exercised, the secured creditor shall, simultaneously with the statement on purchase, be obligated to pay the price agreed with the third party, or deposit it with the court, in line with the application of rules on the price payment deadline from the Law on Contracts and Torts – LCT (Article 528, paragraph 2) [54]. LCT regulates that the rules on sales with preemptive rights shall be applied accordingly to the legal preemptive right (Article 533, paragraph 4).

Exercise of preemptive right through related parties

Separate, that is, pledge creditor may exercise preemptive rights through related persons in the sense of the Law on Companies [56] with submission of evidence that such person is indeed related.

Considering a widespread practice of banks (as the most common secured creditors) to, due to regulatory limitations, establish special companies for the purpose of purchase of claims or assets that are collateral in cases of enforcement or bankruptcy, the banks are enabled in this manner to exercise the preemptive right through related persons, too.

Law on Banks [57] (Article 34, paragraph 2) prescribes collective limitations, that is, a limit of 60% of bank's capital for investments into entities in the non-financial sector as well as fixed assets and investment real estate of the bank. The same regulatory limitation has been prescribed by the Decision on Bank's Risk Management [31] (Item 60) that defines investment risks of the bank, stating that such risks include the risks of investments into other legal entities, fixed assets and investment real estate, as well as limitations according to which bank's investments into one entity that is not in the financial sector may not exceed 10% of its capital, where this investment entails investments that result in the acquisition of shares or stock of the non-financial entity, and the total investment of the bank into entities which are not in the financial sector and fixed assets and investment real estate of the bank may not exceed 60% of bank's capital, where this limit does not refer to the acquisition of shares for sales within six months from such acquisition. Hence, in assessing the investment limit, investments of the bank into non-financial entities (for example, if the bank founded a limited liability company, or acquired a share or stocks in a company during the process of reorganization through the conversion of claims of banks and other creditors into capital – shares or stocks in the bankruptcy debtor) shall be added to the investments of the bank into fixed assets and investment real estate [19, p. 74].

Cancellation of sales as a consequence of the secured creditor's preemptive right violation

Law on Bankruptcy does not prescribe sanctions, that is, legal consequences for the violation of preemptive rights of secured creditors [20, pp. 34-38]. Hence, it can be concluded that general rules from LCT shall be applied (Article 527-532) that regulate sales with preemptive rights [15, p. 458]. Persons that hold preemptive rights in line with the law must be notified in writing on the intended sales and their terms, otherwise they shall be entitled to request the cancellation of sales (LCT, Article 533, paragraph 2). Therefore, the secured creditor with the legal preemptive right over the subject of secured right or lien shall be entitled to demand the cancellation of sales through direct agreement in case of failure to duly notify such creditor on intended sales and their terms [19, p. 76]. At the same time, the secured creditor shall be entitled, that is, he must demand that the asset is sold to him under identical terms, by way of a collective claim with the request for sales cancellation. Otherwise, in case the plaintiff (secured creditor) does not request the cession under the same terms, then there is no legal interest for a suit for sales cancellation which is a process obstruction and a reason for dismissal [35, p. 194].

According to legal opinion of the Civil Department of the Court of Appeals in Novi Sad from 26 May 2014, the probable cause of the claim of the holder of preemptive rights depends on the deposition of funds in the amount of monetary market value of the real estate: "Depositing cash in the amount of market value of the real estate simultaneously with the suit is the basis for probable cause of the claim of the holder of preemptive right for the cancellation of the real estate sales agreement and the request for selling the property to such holder under the same terms" [7]. Due to the violation of priority in the acquisition of rights that is the essence of the preemptive right, in this way, priority purchase right is activated, which is also included in this right. The priority purchase right occurs only if preemptive right has been violated by concluding a contract with a third person [1, p. 148]. "Preemptive right occurs where there is still no contract, and the priority purchase right occurs only after the conclusion of the valid sales agreement between the owner and the third party" [27, p. 1114].

The exercise of authority arising from preemptive right is related to strict legal, preclusive deadlines, whose expiry leads to the loss of preemptive right [1, p. 148]. Therefore, knowledge of the plaintiff about the transfer of ownership, that is, precise contract terms after the expiration of the objective five-year period from the transfer of such ownership to a third party is not legally relevant and has no significance related to the maintenance of such deadline, nor can it lead to the extension of such objective period.

Therefore, regardless of the fact that the duration of the legal preemptive right is not limited (LCT, Article 533, paragraph 2) unlike the contractual preemptive right that shall cease after five years from the conclusion of the contract (LCT, Article 531, paragraph 2), the right to protect the legal preemptive right of the separate or pledge creditor, that is, sales cancellation claim, shall be subjected to preclusive subjective six-month deadline starting on the day of receiving knowledge on such transfer, that is, precise contracted terms, where the preemptive right shall cease in any case upon the expiration of the objective five-year deadline from the transfer of ownership to a third party (LCT, Article 532).

The verdict of the Supreme Court of Cassation, Rev. 1788/2017 from 13 September 2018, adopted through the application of the Law on Real Estate Trade (Article 10, paragraph 2) that also prescribes a subjective-objective deadline, included a position on preclusive legal nature of the subjective deadline: "With the expiration of the subjective deadline of 30 days starting from the day of receiving knowledge about the conclusion of the real estate sales agreement, the owner of the neighboring plot shall lose the right and possibility to exercise the protection of preemptive right" [8].

According to jurisprudence, legal preemptive right is applied *erga omnes,* while the contracted preemptive right is applied *inter partes,* that is, it can be exercised towards a third party only in case of negligence in a specific case [33, p. 576]. "Right of priority purchase can always be exercised in case of violation of the legal preemptive right, and in case of violation of the contractual preemptive right only if the

person to which the asset was sold was negligent, that is, if such person knew or should have known that preemptive right has been violated" [1, pp. 147-148]. Therefore, one could accept a position that negligence of the third party (buyer) is not a precondition for the adoption of the claim of the separate, that is, pledge creditor, as the holder of the legal preemptive right for the cancellation of sales and cessation of asset under the same terms. In this case the right to damage compensation towards the bankruptcy administrator and/or bankruptcy debtor would belong to a third party and it would be treated as an obligation of the bankruptcy estate [19, p. 79].

Consent of secured creditors for the lease of assets burdened by secured rights or lien

Leasing assets of the bankruptcy debtor burdened by secured rights or lien shall be considered a matter of utmost importance (Article 28, paragraph 1) and shall be conditioned on the consent of secured creditors (Article 28, paras 2-4), regardless of their value compared to the total value of bankruptcy estate [36, p. 120].

The bankruptcy administrator shall deliver the notice on the intent to lease to secured creditors and such action may be implemented only with the receipt of the approval of creditor that, in line with the application of rules of assessment of the probability of settlement for the purpose of voting at the creditor's assembly (Article 35, paragraph 3), makes probable that his secured claims may be settled from the assets under burden in part or in whole (Article 28, paragraph 2). Therefore, the probability of settlement of the secured claim may be proved by secured creditors by delivering the appraisal of the value of assets that is the subject of secured right prepared by the authorized professional (appraiser), not older than 12 months.

To avoid the possibility of abuse of this right by creditors that have no basis to expect any settlement from the value of such assets (if they are holders of the lower priority right), the consent shall be received only from the creditors that present the probability of settling their secured claims from assets under burden (in whole or in part). Therefore, the precondition for the use of this right is proving the probability (which represents a lower degree of evidence than certainty) of settlement from the property being subjected to leasing. Interests of secured creditors may differ depending on their position, thus the interest of some of them may be sales, while others may have interest in leasing [25, pp. 111-112].

Bearing in mind that secured creditors are justifiably interested in preservation of the subject of collateral of their claim and its earliest possible cashing in, their consent is required since these are transactions that include providing subject of pledge to a third person for use, thus, potentially, over time, its value may be depreciated for example, from regular use. Moreover, leasing will, *de facto,* delay cashing in of such assets (due to the fact that in this manner fixed monthly costs of bankruptcy proceedings are financed), which is contrary to the urgency principle of bankruptcy proceedings and legitimate interests of secured creditors that have no benefit from leasing, the benefit is attributed to the bankruptcy estate. Opposed interest of secured creditors on the one side and the bankruptcy administrator and regular creditors on the other are balanced by not denying the bankruptcy administrator to lease property burdened by secured right or lien, but such right is conditioned on the consent of secured pledge creditors [24, pp. 28-29].

In case of lack of declaration for any reason, that is, failure to submit to the court explicit written rejection of consent, a fiction of the existence of consent of secured creditors has been prescribed for the lease of assets under burden. Consent shall be considered given in case secured creditors fail to submit their statement related to the matter within eight days from the receipt of the written request of the bankruptcy administrator (LB, Article 28 paragraph 3). The law, therefore, prescribes the fiction that the consent was provided tacitly which is a deviation from the basic principle in law that silence does not mean approval (LCT, Article 42, paragraph 1).

Clarification of the draft of the law falsely qualified this institute as a "non-rebuttable presumption" [24, p. 29] even though it is a fiction since the law considers the consent given, even though actually it was not. Legal presumption has another role – it presumes a fact, that actually exists in reality, cancelling the requirement of proof, or in case of rebuttable presumptions, transfers the burden of proof to the other side.

This solution secures efficiency of consent provision process by imposing the obligation to act to non-consenting secured creditors, while the bankruptcy administrator is not obligated to actively pursue such consent, which may be a time-consuming process, especially in case of secured creditors that are companies with a complex structure of decision making, such as banks.

Consent of secured creditors has been introduced due to the issues in the application of prior bankruptcy framework that occurred in the instances of lease of assets burdened by secured rights. On the one hand, bankruptcy administrators were motivated to lease the assets of the bankruptcy debtor, thus covering the costs of bankruptcy proceedings. On the other hand, this prevents prompt cashing-in of assets of the bankruptcy debtor. Solutions that were in use before the novelties from 2017 prescribed receiving the consent from the board of creditors but, considering the fact the members of the board were exclusively bankruptcy creditors (except in the case where the board included creditors that were secured and bankruptcy creditors at the same time), the interest of such a board was, as a rule, leasing such assets. Such solution significantly harmed the interest of secured creditors.

The Law on Bankruptcy does not prescribe the legal consequence of leasing property without due notification of secured creditors or in the case where they explicitly deny providing such consent. Consent for contract conclusion is an institute of the contractual law. If third party consent is mandatory for contract conclusion, such consent may be provided prior to contract conclusion, as a permission, or after conclusion, as an approval, unless the law prescribes otherwise (LCT, Article 29). It can be concluded that the consent from the Law on Bankruptcy (Article 28, paras 2-4) is actually a permission, since it is provided prior to the lease agreement conclusion. Therefore, lease agreement shall not be valid if concluded without the consent of secured creditors. It is a completely null transaction (LCT, Article 103) since it contradicts the quoted regulations. More precisely, it is considered that such contract had never been concluded since the law prescribed prior consent – permission of the secured creditors "for contract conclusion", that is, for taking "action" of leasing assets under burden.

Conclusion

Law on Bankruptcy distinguishes separate and pledge creditors as two categories of secured creditors. The differentiation criteria are whether the creditor has claims towards the bankruptcy debtor that are secured by mortgage or pledge over the assets of the bankruptcy debtor, that is, whether the bankruptcy debtor is, at the same time, the debtor of secured claim or it is a third party.

Legal consequences of initiating bankruptcy proceedings over the owner of property under mortgage or movables under pledge, primarily the moratorium, have significant impact on the exercise of rights and the position of secured creditors, regardless of the fact that they do not lead to the cessation of real estate collaterals, since, as a rule, they disable the implementation of the procedure of individual enforcement and settlement outside of bankruptcy, thus limiting their rights. Therefore, it was necessary to provide additional protection of rights to this category of creditors in the procedure of sales of assets of the bankruptcy debtor. For this purpose, having in mind the significance of real estate collaterals, such as mortgage or chattel mortgage, in the operations of banks and other economic entities, the bankruptcy framework in the Republic of Serbia prescribes several specific institutes establishing a separate protection mechanism and exercise of rights of secured creditors.

Amendments to the law from 2007 introduced a new model of settlement for secured creditors, enhancing the mechanism of cashing in the assets of the bankruptcy debtor. Secured creditors were now able to independently implement the procedure of individual settlement of their claims from the assets over which they hold lien. Nine-month period has been set during which individual settlement of secured creditors is allowed, after the cancellation of moratorium. In case secured creditors fail to execute settlement during this period, moratorium is reestablished.

The bankruptcy judge shall not adopt a decision on security measures cancellation, that is, prohibition or enforcement and settlement if the bankruptcy administrator is able to prove that the assets in question are of key importance for the reorganization or sale of the bankruptcy debtor as a legal entity. This introduces

the obligation of proving significance of assets for the reorganization or sales of the bankruptcy debtor as a legal entity, while the burden of proof has been transferred to the bankruptcy administrator.

Credit bidding provides the right for the secured creditor to, in case of the sales of assets under burden, bid and use the amount of its claim instead of cash to pay the price. In this manner secured creditors are able to control the sales of assets over which they hold lien and to react in case they think that the received price of collateral from public bidding, and their settlement, is not adequate. The basis of the credit bidding institute is compensation.

One of the consequences of initiating bankruptcy proceedings is the establishment of the legal preemptive right for the benefit of secured creditors and their related parties over the subject of secured right, or lien, in case of method of sales through direct agreement. This additionally protects their position in situations where there is no public announcement of sales, and without reducing the bankruptcy estate, since such creditor, in case it wishes to exercise this right, must offer at least the same terms as the best bidder.

Law on Bankruptcy does not prescribe sanctions for the violation of preemptive rights of secured creditors, which means that the general contractual law provisions shall apply that prescribe that persons holding preemptive rights by law must be notified in writing on the intended sale and its terms, otherwise they shall be entitled to demand sales cancellation.

Leasing assets of the bankruptcy debtor burdened by secured right or lien shall be considered an action of utmost importance and shall be conditioned on the consent of secured creditors, regardless of their value compared to the value of the total bankruptcy estate. Lease agreement shall not be valid if concluded without the permission of secured creditors.

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TECHNOLOGICAL SOLUTIONS IN LOGISTICS 4.0

Tehnološka rešenja u Logistici 4.0

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Abstract

Technological development, automation, digitalization, networking, new forms of communication, etc. initiated a new industrial revolution, also known as Industry 4.0. It represents a new form of organization and control of the value chain in the product life cycle. By connecting and synergizing existing and new solutions and technologies of communication, data collection, exchange and analysis, production, process management, trade, etc. a new paradigm of human action, business and living has been created. A concept that is intensively changing production processes has emerged, but its effects are also visible in other areas of human activity, primarily trade, health, agriculture, logistics, etc. By applying the solutions and technologies of Industry 4.0 in the field of logistics, the concept of Logistics 4.0 was developed with the aim of achieving greater efficiency of logistics systems and processes. New technologies and solutions appear every day, but the backbone of the development of the Logistics 4.0 concept is comprised of several key technologies, such as: Internet of Things (IoT), Autonomous Vehicles (AV) and Automatic Guided Vehicles (AGV), Artificial Intelligence (AI), Virtual Reality (VR) and Augmented Reality (AR), Big data, Data mining, Blockchain, Cloud Computing (CC), 3D printing, etc. The aim of this paper was to define and describe in detail the aforementioned technologies, as well as the possibilities of their application in the logistics systems and processes through a review of the relevant literature in this field. It can be concluded that logistics, as a multidisciplinary science, represents a fertile ground for the acceptance and further development of existing modern technologies, but also the initiator and incubator of new technologies that could easily go beyond logistics and become part of the family of Industry 4.0 solutions.

Keywords: *Industry 4.0, Logistics 4.0, technologies, IoT, AV, AI, AR.*

Sažetak

Tehnološki razvoj, automatizacija, digitalizacija, umrežavanje, novi oblici komunikacije itd. doveli su do pokretanja nove industrijske revolucije, poznate i kao Industrija 4.0. Ona predstavlja novi oblik organizacije i kontrole lanca vrednosti u životnom ciklusu proizvoda. Povezivanjem i sinergijom postojećih i novih rešenja i tehnologija komunikacije, sakupljanja, razmene i analize podataka, proizvodnje, upravljanja procesima, trgovine itd. stvorena je nova paradigma ljudskog delovanja, poslovanja i življenja. Nastao je koncept koji intenzivno menja proizvodne procese, ali čiji su efekti vidljivi i u ostalim oblastima ljudskog delovanja, pre svega trgovini, zdravstvu, poljoprivredi, logistici itd. Primenom rešenja i tehnologija Industrije 4.0 u oblasti logistike razvio se koncept Logistike 4.0 sa ciljem postizanja veće efikasnosti logističkih sistema i procesa. Svakodnevno se pojavljuju nove tehnologije i rešenja, ali okosnicu razvoja koncepta Logistike 4.0 čini nekoliko ključnih tehnologija, kao što su: internet stvari (IoT), autonomna (AV) i automatski vođena vozila (AGV), veštačka inteligencija (AI), virtuelna (VR) i proširena stvarnost (AR), Big data, Data minig, Blockchain, Cloud Computing (CC), 3D štampa itd. Cilj ovog rada je bio definisati i detaljnije opisati pomenute tehnologije kao i mogućnosti njihove primene u logističkim sistemima i procesima kroz pregled relevatne literature iz ove oblasti. Može se zaključiti da logistika, kao multidisciplinarna nauka, predstavlja plodno tlo za prihvatanje i dalji razvoj postojećih savremenih tehnologija, ali i inicijator i inkubator novih tehnologija koje bi lako mogle da izađu iz okvira logistike i postanu deo porodice rešenja Industrije 4.0.

Ključne reči: *Industrija 4.0, Logistika 4.0, tehnologije, IoT, AV, AI, AR.*

Introduction

Nowadays is considered as the era in which the fourth industrial revolution, also known as Industry 4.0, began. Like the previous ones, this industrial revolution was started and intensified by the growth of competition whose basic measures are efficiency, flexibility, speed, ability to transform, costs, etc. [41]. It is based on innovation in industry and it represents one of the key factors in the economic development of companies and countries [125]. The basic characteristics of Industry 4.0 are digitalization, automation, networking and development and application of new technologies in order to increase productivity and production in accordance with the specific requirements of the users [130]. The implications of Industry 4.0 significantly go beyond the field of production and expand into various spheres of social activity. One area that has been particularly fruitful for embracing and advancing Industry 4.0 ideas is logistics. Accordingly, in recent years the concept of Logistics 4.0 has been developed, which implies the application of solutions and technologies of Industry 4.0 in logistics. Just as Industry 4.0 has led to the radical changes in manufacturing processes, so has Logistics 4.0 transformed the way organizations buy, produce, sell and deliver goods [22]. Therefore, Logistics 4.0 has become one of the most common topics of discussion for experts in the field of logistics and supply chain management [22, 115, 137]. They strive to adequately look at existing solutions, systematically develop new ones and find ways to share them in order to achieve greater efficiency of logistics systems and processes. New thinking models, frameworks for the development of solutions and technologies and procedures for the implementation of processes aimed at establishing Logistics 4.0 as the new research area are being developed [41]. Accordingly, the subject of this paper is Logistics 4.0 as an application area of Industry 4.0, and the aim of the paper is to review the technologies of Logistics 4.0 and specific examples of application for the processes implementation and problem solving in the field of logistics.

The paper is organized as follows. The following section presents the terminology and provides the basic definitions of Industry 4.0. After that, Logistics 4.0 was defined and its basic characteristics and conceptual framework were described. The fourth chapter describes in more detail the technologies of Industry 4.0 that have found the widest application in the field of logistics, or have the greatest potential to do so in the future. The last chapter provides concluding remarks and directions for future research in this area.

Industry 4.0

Industry 4.0 was first mentioned as a term in one of the German government's high-tech strategic projects in 2011 [65] and originally referred to the software nomenclature. Today, this is a widely accepted term used as a synonym for the fourth industrial revolution. However, there is a discussion in the literature about what this term means and what it encompasses, which is why a large number of different definitions have emerged. Hermann et al. [54] defined Industry 4.0 as a common name for the application of new technologies and concepts in the organization of the value chain. Götz & Gracel [43] defined it as a complex solution created in the sphere of common interest of engineering, computer science and management. Industry 4.0 is also defined as smart networking of machines and processes in industry using information and communication technologies [102]. What all definitions have in common is that Industry 4.0 implies the integration of computing, networks and real physical processes, thus creating a Cyber-Physical System (CPS) which is the basis for the development of new business models and solutions [41]. Various technological solutions are used for this integration, such as: Internet of Things (IoT), Cloud Computing (CC), robotics, Artificial Intelligence (AI), Augmented Reality (AR), Big Data, Machine Learning (ML), 3D printing, etc.

Most of the listed technological solutions that define Industry 4.0 already exist and are widely applied, so many authors question whether it is a revolution or evolution [1, 68, 43]. Industry 4.0 is a conglomeration of already known solutions and applications, but for the first time they are connected in a complex network of interdependent elements, so it can be viewed as an innovative concept. However, whether it represents a revolution or an evolution, Industry 4.0 has defined a new paradigm of human action, business and living.

The primary goal of Industry 4.0 is to make ordinary objects self-aware and self-learning in order to improve their performance and ability to interact with the environment [74]. The aim is to form an open smart platform for networking information applications and technologies [5]. The main needs of Industry 4.0 are real-time monitoring of data, monitoring the status and position of objects and having adequate guidelines for control of the processes that objects perform [2]. Accordingly, the basic prerequisites for the development of Industry 4.0 are the availability of real-time information through networking of all elements (objects, users, technologies) involved in the value creation, the ability to deviate at any time from the optimal way of implementing the process in accordance with the available information and data and the possibility of performing processes that create value by integrating different information [41]. Networking involves connection of the different users, communication between the objects and their components, and exchange of the information about status, position, destination, purpose, etc., allowing products or services to adapt to changing user requirements.

The effects of Industry 4.0 development are significant cost reduction of production, maintenance, logistics, energy consumption, quality improvement, etc., more rational use of resources, creation of new business models and strategies for planning and managing business processes, optimization of the entire value chain, creation of new occupational profiles, increasement of the levels of competitiveness of economic entities and the economy in general [41]. Industry 4.0 enabled the collection of large amounts of data, their adequate interpretation and multi-purpose application, connection of the different software solutions, decentralization of business process control, modularization of products and services, creation of the business process support systems, changes in the work environment, higher level of automation reflected in better cooperation of robots and humans, a high level of self-organization and autonomy in the production of products and services, etc. [41]. Industry 4.0 is mostly seen as a concept that intensively changes production processes, but its effects have far-reaching impacts on various areas of human activity such as manufacturing, trade, health, agriculture, logistics, etc.

Logistics 4.0

A new approach in the realization of production processes has defined new logistics requirements. Accordingly, Logistics 4.0 is increasingly mentioned as a concept that is strictly related to the concept of Industry 4.0 with which it shares the goals, assumptions and operating conditions [68]. In the literature, the term Logistics 4.0 is often equated with the term smart logistics [6, 68, 98]. Jeschke [61] views Logistics 4.0 as an integral part of Industry 4.0 which refers to the application of various technologies that define Industry 4.0 (IoT, CC, AI, AR, ML, etc.) in the field of logistics. Similarly, Barreto et al. [6] defines Logistics 4.0 as the realization of logistics processes with the application of innovations and applications brought by the development of CPS. Timm & Lorig [123] defined Logistics 4.0 as a transformation from hardware-oriented logistics to software-oriented logistics. Winkelhaus & Grosse [141] identified three dimensions that unite the ideas of logistics and Industry 4.0: a change of production paradigm directed towards mass customized production, changes in logistics systems and processes caused by the application of new technologies and changes in the environment and human role in industrial and logistics systems and processes. Accordingly, they formulated a three-dimensional conceptual framework (Figure 1) and defined Logistics 4.0 as a logistics system that enables sustainable fulfillment of individual customer requirements without increasing costs and with the development of the industry and trade supported by the digital technologies.

The first is external, the so-called pull dimension, which includes paradigm shift due to user demands for high quality personalized products, development of Industry 4.0, globalization, demands for sustainable development, social change, etc. [55, 70, 141]. The second is technological, the so-called push dimension, which encompasses the various technologies of Industry 4.0 that enable paradigm shift and drive the transformation of traditional logistics operations [70, 141]. The third is the logistical dimension defined by competencies, functions and human factors. Competencies relate to management activities [59] and task execution [47]. These activities are implemented within four basic functions in terms of flows: procurement logistics,

production, distribution and logistics of returnable and waste materials [47]. Human factors, such as knowledge, skills, physical limitations, psycho-social interaction, decision making (subjectivity), motivation, etc. significantly affect the quality and efficiency of logistics activities. Human labor will never be completely replaced by machines in Logistics 4.0, but their labor will be strongly influenced by new technologies. In addition, people are the ones who make the final decision on accepting or rejecting a technology, which directly shapes the further development of Logistics 4.0 [127].

Various Industry 4.0 technologies that can be applied in logistics have been identified in the literature, and some of them are shown in Table 1. The technologies that have the greatest potential for wide application in logistics are described in more detail below.

Figure 1. Conceptual frame of Logistics 4.0 (adapted from [141])

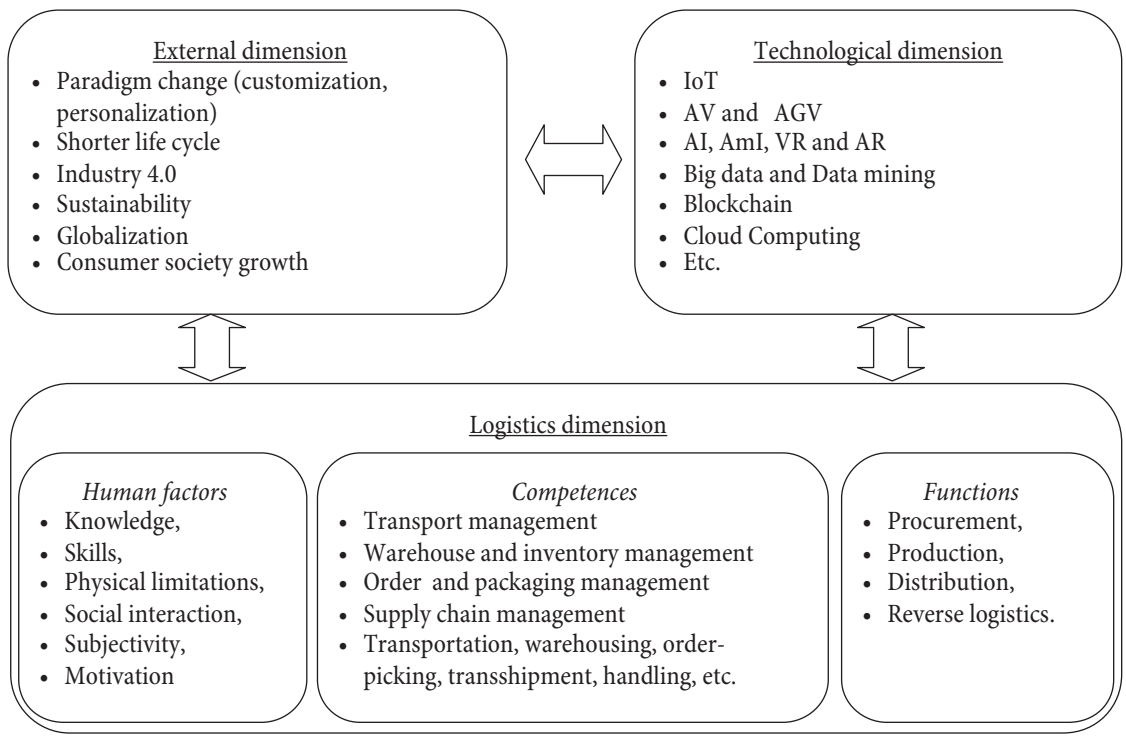

Table 1. Overview of the most common technological solutions in Logistics 4.0

	Kostrzewski et al. [68]	Tang & Veelenturf [120]	Lee et al, [72]	Lin & Yang [78]	Schmidtke et al, [109]	Horenberg [56]	Pesti & Nick [100]	Barreto et al, [6]	Wagener [135]	Galindo [37]	Juntao & Yinbo [64]	Mussomeli et al, [92]
Internet of Things (IoT)		x	x	x						x	x	
Autonomous and Automated Guided Vehicles (AV and AGV)	x	x		x		x	x				x	x
Artificial (and Ambient) Intelligence (AI and AmI) and Augmented (and Virtual) reality (AR and VR)		x	x	x								x
Big data and Data mining (BD and DM)					x					x		
Data security and Blockchain (BC)		x				x		x				
Management and control support systems and Cloud Computing (CC)	x		x		x		x	x	x	x	x	x
E-Marketplace and M-Marketplace						x			x			
3D printing						x						
Advanced robotics	x	x										

Technological slutions in Logistics 4.0

At the level of application, prototype or concept, there is a large number of technological solutions that are associated with Industry 4.0, and new ones appear every day. Some of them are more or less applicable in the field of logistics, and below are described in more detail those that have had the greatest impact so far, or have the potential to greatly affect logistics systems and processes in the future.

Internet of Things (IoT)

The term Internet of Things originated in 1999, and was coined by Kevin Ashton while working on promoting RFID technology [82]. The very idea of connecting devices was present much earlier, since the 1970s, and was then generally called "embedded internet" or "pervasive computing" [68]. However, it has gained wider application and popularity only in the last decade, and it has been widely used since 2014 [82]. There are many different definitions of IoT in the literature. Uckelmann et al. [128] define it as a set of sensors and actuators built into physical objects that are interconnected by wired or wireless networks and typically use the same Internet Protocol (IP). A similar definition is given by Gubbi et al. [46] and Hozdić [57], which under IoT imply a global network of interconnected objects that communicate with each other through standard protocols. A somewhat more general definition is given by Lu et al. [81] which define IoT as a technological paradigm whose goal is to connect everything and everyone, anytime and anywhere. In line with the latter definition, some researchers are expanding the concept of IoT and calling it the Internet of Everything (IoE), which integrates Internet of Services (IoS), Internet of Manufacturing Services (IoMs), Internet of People (IoP) and Information and Communication Technologies (ICT) into a single system [95]. Thus, IoT is used as an umbrella term to cover various aspects of the expansion of the Internet and networks into the physical environment.

Xu et al. [145] state that IoT consists of four basic layers: sensors that integrate different types of "things", a network that enables information transfer, services that integrate different applications and software solutions, and an interface that presents information to the user and interacts with the system. Similarly, Lee & Lee [73] define the structure of IoT as a combination of radio frequency identification (RFID) technologies, wireless sensor networks (WSN), middleware, cloud computing (CC) and IoT applications. RFID enables the identification, tracking and transmission of information through various types of tags, from completely passive to active [80]. WSN is a network of interconnected sensors that track and monitor the status of various objects, such as location, movement, temperature, pressure, noise, air quality, humidity, speed, etc. [104]. Indirect software allows developers to communicate with various devices via sensors, actuators, RFID tags, etc. [8]. It is the link between the hardware and the interface. CC is a platform that uses the Internet to enable sharing and use on demand of various computing resources (such as various computing components, networks, storage capacity, software, etc.) [73]. The result is the ability to store large amounts of data, process them quickly and make efficient decisions in real time. IoT applications form an interface that allows people and objects to interact, present information in an intuitive and understandable way, identify problems, and suggest solutions [73].

Kim & Kim [66] point out that logistics is one of the areas that has benefited the most from the application of IoT. This is made possible by connecting over 26 billion facilities (vehicles, transport units, handling equipment, infrastructure facilities, etc.) worldwide in 2019, and it is estimated that by 2025 that number will go over 75 billion [68]. IoT has found application in all subsystems of logistics. In the ordering subsystem, it is used for order management and information exchange (e.g. [103]), creating a digital bill of lading (e.g. [144]), etc. In the transport subsystem, it has found application for locating and routing (e.g. [79]), fleet maintenance and fault prevention (e.g. [10]), fleet management (e.g. [118]), establishment of the autonomous vehicles systems (e.g. [60]) and drones (e.g. [9]), transport quality control (e.g. [111]), monitoring of various transport parameters in real time (e.g. [19]), increasing transport safety (e.g. [71]), protection of cargo from damage, alienation, etc. (e.g. [116]), etc. In the storage

and inventory subsystems, it is used for the management of storage processes (e.g. [118]), warehouse security (e.g. [124]), inventory (e.g. [121]), etc. Within the packaging subsystem the IoT technology enabled the development of the systems for the organization and control of automatic packaging (e.g. [77]) and labeling (e.g. [139]), as well as the design of smart packaging with the ability to monitor various parameters (e.g. [53]) etc.

Autonomous (AV) and Automated Guided Vehicles (AGV)

Although the terms autonomous vehicles and automated guided vehicles are similar and are sometimes used with the same meaning in the literature, there are differences between them. AGVs are an older invention. They first appeared in the United States in the 1950s, and ten years later in Europe (Germany) [129]. They imply vehicles that are remotely controlled or that are self-controlled following a predefined path, where radio waves, cameras, magnets, lasers, etc. are used for their guidance [63]. Autonomous vehicles, also called in the literature Fully Automated Vehicles, Self-driving Cars or Driverless Cars, have been developing more intensively since 2009 and presentation of the Google self-driving vehicle [134]. They imply adaptable and self-learning vehicles that are able to "feel" the environment and move safely in it with little or no help from people [119]. It can be said that autonomous vehicles are a type of automated guided vehicles that do not have a fixed, predefined path, but decide on the path independently based on information from the environment and algorithms and software solutions that are part of their operating system.

Differences between AV and AGV also exist from the aspect of application in logistics. AGVs are mainly used in storage and transshipment subsystems, while in the transport subsystem their application is mainly limited to internal transport. On the other hand, AVs are currently used exclusively in the transport subsystem. In the literature, a distinction is usually made between the application of AGVs indoors for horizontal (e.g. [117]) and vertical transport (e.g. [58]), transshipment (e.g. [27]), storage/retrieval (e.g. [30]) and order-picking (e.g. DHL, [27]), and outdoors in the strictly controlled environment (such as terminals, logistics centers, ports, airports, industrial complexes, mines, etc.) for horizontal transport (e.g. [15]) and transshipment (e.g. [45]). Road AGVs are predominantly used, but there are examples of the application of both rail (e.g. [25]) and air (e.g. [138]) vehicles. On the other hand, the literature has identified applications of AVs in short-haul transport (for the realization of the last mile) (e.g. [91]), as well as in long-haul transport (e.g. [90]). They are also predominantly used in road transport, but their application in rail (e.g. [97], waterway (e.g. [76] and air transport (e.g. [35]) is also possible.

In line with the applicability, the main areas of research for AV and AGV are technological solutions, responsibilities and regulations, ethics and the human factor [131]. Research on technological solutions deals with the basic components of the system in charge of observation and modeling, localization and mapping, path planning and decision making, and motion control [112]. Simply put, the ability of a vehicle to collect and interpret data from the environment and plan and execute activities based on them, is investigated [4]. The need to change regulations in this area and to define responsibilities are the main obstacles to wider application, primarily of the AVs, which is why this is the subject of frequent discussions and research [131]. Considering that driving involves constant risk assessment and decision-making that can be legally but also morally ambiguous, Goodall [42] points out that significant attention needs to be paid to ethical issues in research. Finally, although both AV and AGV systems tend to involve humans minimally, their direct or indirect impact on the operation of these systems is inevitable, which is why the human factor is a particularly important area of research [126].

Artificial (and Ambient) Intelligence (AI and AmI) and Augmented (and Virtual) reality (AR and VR)

The term Artificial Intelligence was first officially used in 1956 at the University of Hanover (USA) [107]. There are many different definitions of AI in the literature. Bellman [7] defines AI as the automation of activities related to

human thinking, such as decision making, problem solving, learning, etc. Kurzweil [69] defines it as the art of creating machines that realize functions that require intelligence when realized by humans. Winston [142] under AI implies the study of calculations that enable observation, reasoning and action. Luger & Stubbllefield [83] define it as a field of computing that deals with the automation of intelligent behavior. All definitions can be classified into those whose focus is on thinking and reasoning and those with a focus on behavior, as well as those according to which AI achieves rational thinking or human thinking [107]. According to today's modern understandings, AI in the broadest sense implies the ability of a computer to perform tasks that are usually performed by intelligent beings, above all observation, reasoning, problem solving, learning and communication [21].

Artificial Intelligence has enabled the development of some new technologies, including Ambient Intelligence (AmI), Augmented Reality and Virtual Reality. AmI is essentially associated with AI and actually represents AI in the environment [38]. The term originated in the last years of the 20th century [48], and implied an electronic environment that is sensitive to the presence of people and enables interaction with them [38]. Later, the meaning of the term was expanded to include an environment without the presence of people. According to the modern definition, AmI implies a multidisciplinary approach that aims to improve the way the environment and people interact in order to create new opportunities to use the space in which people live and work [38]. Some of the new ways to achieve this interaction have enabled the development of augmented and virtual reality technologies.

AR is defined as a direct or indirect view of the physical environment in real time, which is enhanced/expanded by the addition of computer-generated virtual information [16]. VR, on the other hand, involves a computer-generated simulation in which interaction with artificial three-dimensional space is possible [89]. Milgram et al. [88] defined the so-called Milgram's Real-Virtual Continuum, which encompasses the space between the real and virtual environment in which AR and VR are located, where AR is closer to the real and VR to the virtual environment. AR provides users with an enhanced real-world experience, while VR enables the creation and experience of a virtual environment. Both technologies use various types of glasses, helmets, gloves, mobile devices (phones, tablets), etc. as media.

The aforementioned technologies have found wide application in the field of logistics. They can be used to process purchase orders (e.g. [148]), in the storage subsystem for the implementation of transshipment operations, storage/retrieval, locating/allocating goods and handling equipment, (e.g. [99]), loading and unloading of transport units/means, order-picking (e.g. [114]), management and control of warehousing processes (e.g. [105]), etc., in the inventory subsystem to optimize inventory levels (e.g. [99]), in the transport subsystem for monitoring the status of goods and vehicles in the fleet management systems (e.g. [49]), vehicle routing (e.g. [62]), vehicle navigation in conditions of reduced visibility, primarily in water transport (e.g. [13]), driving skills improvement (e.g. [84]), transport safety improvement (e.g. [96]), etc.

Big data and Data mining

Industry 4.0 implies the application of technologies based on the collection, processing and analysis of large amounts of data, so in this context, the term Big data appears increasingly. Wu et al. [143] define Big data as the process of collecting large amounts of data from heterogeneous and autonomous sources, with shared and decentralized control, with the goal of finding complex and variable relationships between them. Similarly, Sagiroglu & Sinanc [108] define Big data as massive data sets that have a large, volatile, and complex structure that is difficult to store, process, and visualize for further processing or obtaining the results. The goal is to obtain useful information that companies or organizations can use to better understand various aspects of business and gain a competitive advantage in the market [108]. Big data is determined by the basic so-called 3V characteristics: velocity of change and increase in the amount of data, variety of types, shapes and formats of data and the volume of data generated every second [113].

The process of research into large amounts of data to determine hidden patterns and correlations is called Big data analytics [108]. Researchers from various scientific

fields are making great efforts to develop new, fast and dynamic Big data analytics technologies that would also be easy to use [113]. These technologies are actually tools for finding, collecting, transforming, analyzing and visualizing data to make them applicable for efficient decision making, with acceptable resource consumption (time, finances, energy, etc.) [143]. These technologies are collectively called Data mining, or Knowledge Discovery in Databases, and are most commonly created by combining different statistics tools, AI, and database management [20]. The process of determining patterns and relationships in large data sets takes place in five steps: selection, preprocessing, transformation, data research, and interpretation/evaluation [34].

Ghosh [40] identified logistics as one of the main areas of application of Big data and Data mining. They are applied in all subsystems of logistics, i.e. wherever the data applicable to the improvement of the logistics services can be collected. Their application in logistics creates conditions for managing orders (e.g. [17]), transportation (e.g. [136]), warehousing operations (e.g. [18]), inventory (e.g. [44]), packaging processes (e.g. [149]), as well as for capacity planning of available resources, last mile optimization, customer loyalty management, supply chain risks management, etc. [26].

Data security and Blockchain

Technology of the cryptographically protected chain of data blocks was defined by Haber & Stornett [50]. However, the practical application of the name Blockchain, under which it is known today, was introduced only in 2008, when a group of authors under the pseudonym Satoshi Nakamoto [93] used this technology to create a cryptocurrency known as Bitcoin. It implies a decentralized digital register of data sets, i.e. blocks, which are mutually identified and connected on the basis of encrypted information, thus forming chains [94, 101]. These chains are formed within computer networks that represent nodes, which record, share and simultaneously synchronize transactions, thus creating a decentralized database [125]. The basic characteristics of Blockchain technology are: decentralization, verifiability and consistency (invariability) [51]. Decentralization is a consequence of the fact that the network within which the chains are formed is completely managed by its users, without relying on a body that would have centralized competencies over the infrastructure or transactions within the network. In order to add a new block of data to the registry, it is necessary to share it with all users within the network and all users keep their copy of the entire registry. Verification is performed by the digital signature of the network user when adding new data, which is encrypted using a public-private cryptographic key. The application of the cryptographic key enables anonymity in the network because digital signatures are not connected to the identities of people in the real world. Consistency is ensured by the application of consensus algorithms that allow data verification only if consensus is reached by all network users. If a consensus is reached the block is accepted and becomes part of the chain, otherwise it is rejected. Blockchain technology practically prevents any manipulation, which ensures a very high level of data security.

Intensive exchange of a large amount of data has generated a demand for improving the security of these transactions, which is why Big Data is considered to be one of the main drivers of the development of Blockchain technology [122]. Accordingly, Blockchain technology, like Big data, can be applied in all subsystems of logistics, i.e. for the implementation of all processes and activities that require secure data exchange. However, despite the importance and potential, the literature describes only a few fields of application of Blockchain technology in logistics [51, 122, 146]: processing of documentation (purchase order, bill of lading, customs documents, etc.), control of goods (identification of counterfeit products, monitoring of dangerous or high-value products, monitoring of traceability, etc.), support for the application of IoT in logistics and supply chain management.

Management and control support systems and Cloud Computing (CC)

Management and control support systems in this paper imply software solutions that aim to provide support in the management and control of the execution of various

processes and activities in all logistics subsystems. Some of the most commonly used solutions are: Enterprise Resource Planning (ERP), Warehouse Management System (WMS), Inventory Management System (IMS), Electronic Data Interchange (EDI), Transport Management System (TMS), Intelligent Transport System (ITS), telematics systems, Package Management System (PMS) etc.

An ERP system is defined as a comprehensive software package that integrates a wide range of business processes and functions with the goal of providing a holistic business overview and company resource planning accordingly [67]. ERP involves the integration of information from all business areas of the company using common databases and has a modular structure [23]. One of the most important ERP modules is WMS. It is an information system for managing and controlling physical and information flows in a warehouse [110]. It collects and stores information on goods and storage resources and processes and forwards it to other modules of the ERP system [132]. Based on the functions it implements, WMS itself can be divided into seven basic modules for: yard management, storage assignment, storage/retrieval, inventory management, order-picking, shipping and workforce and task management [52]. Of the mentioned modules, the inventory management module stands out, for which special software solutions known in the literature under the common name IMS are being developed. They are in charge of accurately keeping records of the quantities of goods in stock, determining the time and quantity of goods to replenish stocks, recording the time of sale of products and predicting future demand based on that, etc. [3]. Significant inventory reduction can also be achieved by applying EDI systems that are a form of e-commerce within organizations in which one partner (buyer or seller) establishes communication with one or more other partners using various methods of electronic data exchange [75]. EDI enables the formation of a strategy of cooperation between suppliers, distributors and retailers with the aim of faster response to the requests of end users (customers) [133]. Another important module of the ERP system is TMS. It is a platform that combines software solutions, information and communication technologies in order to plan, implement and optimize the physical movement of goods and related activities [106]. The functioning of TMS can be observed through four key processes: planning and decision-making based on real-time information, implementation of transport plans with automated dispatching and carrier selection, improving the visibility of the transport chain for all participants and monitoring key performance indicators [106]. A significant segment of TMS is telematics systems. The term telematics was coined by combining the terms telecommunications and informatics and was initially used exclusively to denote the sending of information via telecommunications systems, while today it also encompasses the fields of computer and electrical engineering, digital technologies and traffic engineering [36]. It is used for information collection about vehicles, navigation, diagnostics, safety improvement, communication between vehicles, etc. [12]. In recent years, with more intensive development of information and communication technologies, IoT, AV, AI, etc., the ITS solutions are also developing. These are the systems for automatic and autonomous traffic and mobility management that is realized by managing transport means, infrastructure, traffic participants, and by connecting and communicating between transport means of different transport modes [33]. PMS includes software tools for the design and production of packaging and marking labels, optimization of dimensions, stacking methods, enlargement, etc. There are many different solutions of these software tools on the market [14].

Most of these solutions are not new and have been applied in practice for much longer than the existence of the Industry 4.0 concept. However, in the Industry 4.0 environment, these solutions are experiencing a renaissance, especially in terms of wide availability and easy application made possible by the concept of cloud computing. CC implies wide and easily accessible network access that allows the use of shared computing resources (e.g., servers, storage capacity, applications, services, software, etc.) that can be quickly occupied and released with minimal service provider engagement [87]. CC defines five basic characteristics, three service delivery models and four application models [87]. The main features are the provision of service at the request

of the user (the user independently selects and launches computer resources when they need them), wide network access (resources can be accessed from any location using various types of devices that can connect to the network), pooling resources (total available resources are created by combining resources of a large number of providers and users who are physically located in different locations), resilience (required resources can be quickly and easily adjusted to user requirements) and service quantification (resource use can be measured as a prerequisite for billing and wide application) [87]. Service delivery models are software as a service (use of programs and applications located in the cloud infrastructure), platform as a service (use of development environment and tools in the cloud to develop own applications) and infrastructure as a service (use of computer infrastructure and resource management for processing and data warehousing, networking, etc.) [87]. The basic deployment models are private cloud (deployment within an organization), shared cloud (deployment within the community with the same or similar interests), public cloud (fully open access for all users) and hybrid cloud (any combination of the aforementioned deployment models) [87].

E-marketplace and M-marketplace

The Internet has made it possible to create e-commerce platforms called Electronic Marketplace (E-marketplace) [32]. E-marketplaces enable automated transactions, trade, or collaboration between business partners [24]. They may differ in relation to sales mechanisms (direct, stock market), ownership (buyer, seller, third party), number of owners (one or more), primary activity (trade, industry, logistics, etc.), participants (private or public, Business-to-Business - B2B, Business-to-Customer - B2C, etc.), type of goods or services and industry orientation (horizontal, vertical, diagonal) [29, 39]. E-marketplace enables simpler, faster and more reliable shopping, information exchange, contract management, market research, order management, orders integration in time and space, development of information systems for tracking inventory and finances, easier promotion and advertising, etc. [31]. With the evolutionary development of the E-marketplace platform, mobile marketplaces (M-marketplace) have emerged and include platforms on which trade is realized using mobile devices (mobile phones, tablets, laptops, etc.). Social trends have influenced Internet users to increasingly turn to mobile technologies, therefore many of the activities they once carried out on personal computers are now carried out via mobile devices, anywhere and at any time. Like some of the technologies described above, these platforms were developed well before the Industry 4.0 concept was defined, however with the development of smart mobile devices they are becoming part of the Industry 4.0 paradigm. Smart mobile devices combine telecommunications and computing technologies and use technologies such as Bluetooth, Zigbee, NFC (Near-Field-Communication), Wi-Fi (Wireless Fidelity), Li-Fi (Light Fidelity), WiMax (Worldwide Interoperability for Microwave Access), 4G and 5G, etc., to connect to other devices or networks.

The development of the E-marketplace and M-marketplace platforms has led to the intensive development of the logistics market. Logistics services markets have actually become part of electronic markets because the customer now automatically buys the logistics service with the purchase of products. Logistical requirements are changing, the number of deliveries is growing, the size of deliveries is decreasing, and the requirements from the aspect of delivery quality are becoming stricter (reliability, flexibility, accuracy, etc.). In the literature, the problems of logistics that are related to the electronic and mobile markets are mostly observed from the aspect of creating new models of logistics business and development of the logistics market through expanding the offer and improving services using new technologies, etc. [147].

3D printing

3D printing is a form of additive production that has its roots in stereo lithography created in the mid-80s of the twentieth century [86]. It involves the production of three-dimensional objects by repeatedly adding layers of material. This technology, along with the development of computers and the Internet, has been identified as one of the biggest drivers of radical change in global industry

since the establishment of the first production lines in America in the early twentieth century [85] and a herald of the new industrial revolution [11]. The visions of various authors and companies have shown that there are almost no restrictions on what can be printed. There are examples of 3D printing in almost all branches of industry, from aircraft production, over medical equipment to food [140]. Unlike traditional forms of industry, 3D printing enables easy and fast establishment and start of production lines, locating production plants much closer to end consumers, greater flexibility in relation to changing user requirements, etc. [85]. The impacts of this new production technology are noticeable in many areas, but logistics stands out among them [85].

Mass use of 3D printing could lead to a reduction in international trade flows, especially from Asia, as products could be cheaply produced much closer to the point of consumption. The great variety of products that would result from custom production would lead to a reduction in the level of goods in stock, as well as the need for long-term storage of goods. Logistics providers would be significantly less involved in logistics activities for the procurement of semi-finished products, installation parts and spare parts because they would be produced on site. On the other side, their engagement in the procurement of raw materials and materials for 3D production would increase significantly. There would also be significant changes in distribution logistics, especially in the relations of manufacturers, wholesalers and retailers [85]. In some branches, retail trade could disappear completely or be transformed into showrooms that would not have stocks or sell goods. The sale would be made by the manufacturer himself and the goods would be delivered directly to the home address. The volume of flows in home deliveries would be further increased with the mass use of 3D printers as each house could become a mini production facility requiring raw materials for production [85].

Advanced robotics

The tendency of people to be replaced by machines in work is longer than 500 years and dates back to the period of Leonardo da Vinci. Today, the application of robots in the realization of many complex activities is a reality. In industry, they participate in the production and assembly of products, in medicine they perform complex surgical procedures, in households they perform daily household chores such as mowing the grass or vacuuming, etc.

In addition to the obvious motives for the application of robots, such as a high level of reliability, efficiency, precision, flexibility, etc., the lack of manpower is especially emphasized in logistics [28]. This is a consequence of higher demand for labor due to the intensive development of e-commerce and the demand for frequent deliveries of small quantities of goods, as well as the reduction of labor potential due to lower population growth in developed countries, and migration in the less developed ones. However, despite the need, so far the application of robots in logistics has been limited, primarily for technological reasons. Robots are predominantly stationary, "blind" and relatively unintelligent [28]. They perform the same operations over and over again with a high level of precision and accuracy, which is suitable for some simpler, but not more complex logistics processes. The application of robots in logistics would imply the possibility of performing an unlimited number of combinations of different operations with different objects. Robots must be able to see their environment and objects, to be able to capture them, to move and relocate them freely, and to be able to "think" and coordinate all these processes [28]. With the advent of Industry 4.0 technologies, such as IoT, AV, AI, AiM, etc. all this became possible.

So far, in practice, advanced robotics in logistics has been applied in warehouses for the realization of storage and retrieval processes [28]. At the prototype level are the robots for loading/unloading transport units and means, stationary and mobile robots for order-picking and realization of various VAL (Value Added Logistics) services such as palletizing, de-palletizing, packaging, repackaging, labeling, finishing, processing, etc. [28]. At the concept level are the solutions of fully automated systems of distribution centers, cross-dock terminals and the realization of the last mile in which advanced robots would realize all the processes of handling and transporting the goods [28].

Conclusion

With the spread of the effects of the new industrial revolution, the need of various fields for the adoption and application of new technologies becomes clear. As logistics is one of the fields in which Industry 4.0 has a great influence, this paper explores the implications and possibilities of applying Logistics 4.0 technologies in real circumstances through a review of relevant literature in the field. It can be concluded that the end of this revolution is not in sight and that with new scientific breakthroughs in almost all areas, it will continue to change all areas of human activity. Logistics as one of these areas, not only represents a fertile ground for the ideas of Industry 4.0, but also acts as a driver of many changes aimed at further development of existing, but also development of new technologies and opportunities in industry and logistics. This area of research is very dynamic, new technologies and solutions appear every day or new possibilities of applying existing ones are found. Accordingly, this paper is a cross-section of the current situation and it can be said that its main shortcoming is the inability to comprehensively consider all technologies and solutions and their possible application in the field of logistics. However, the paper represents a good basis for further research of application of the described technologies in the specific organizations, regions, areas of logistics and logistics systems, analysis of the mutual influence of technologies, decision-making on the priority of technology depending on expected effects, etc., as well as for the development of new technologies.

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